DOCUMENT RESUME

ED 287 678 SE 048 632

AUTHOR Garner, Gerald J.; And Others
TITLE Science Safety Handbook for California High Schools.
INSTITUTION California State Dept. of Education, Sacramento.
REPORT NO ISBN-0-8011-0669-9
PUB DATE 87
NOTE 182p.
AVAILABLE FROM Publications Sales, California State Dept. of Education, P.O. Box 271, Sacramento, CA 95802-0271 ($5.75 no binder--ISBN-0-8011-0669-9; $8.75 with binder--ISBN-0-8011-0668-0).
PUB TYPE Reports - Descriptive (141) -- Guides - Non-Classroom Use (055)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Elementary School Science; Elementary Secondary Education; *Emergency Programs; Field Trips; Hazardous Materials; *Laboratory Safety; Outdoor Education; *School Safety; Science Education; Science Instruction; *Secondary School Science; State Legislation
IDENTIFIERS *California

ABSTRACT

This document was prepared in an effort to help science teachers, administrators, and school staff members in California understand and avoid situations in which accidents could occur in the science laboratory or on field trips and outdoor education experiences. It contains major sections on: (1) first aid (including information on animal and insect bites, burns, eye treatment, exposure to potential poisons, cardiopulmonary resuscitation (CPR), and the recognition and treatment of shock); (2) laboratory safety precautions (containing general information, along with safety suggestions for biology, chemistry, and physics laboratories), and (3) general laboratory practices (addressing fire prevention and control, the use of animals in the classroom, the use of goggles and safety shields, field trips, poisonous plants and plant parts, radiation-producing equipment and materials, radioactive materials, earthquake preparation, and the development of an earthquake response plan). The appendices include citations of state legislation and regulations dealing with school safety, and numerous checklists and student statement forms. (TW)

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SCIENCE SAFETY HANDBOOK

For California High Schools

California State Department of Education

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Sacramento, 1987

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SCIENCE SAFETY HANDBOOK

For California High Schools

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Publishing Information

The *Science Safety Handbook for California High Schools* was developed under the direction of the Mathematics, Science, and Environmental Education Unit, California State Department of Education. The preliminary drafts were edited for technical accuracy by William H. Andrews, Educational Program Specialist in the Mathematics, Science, and Environmental Education Unit; and Clifford T. Fredrickson, Curriculum Specialist (retired), San Diego City Unified School District. The final draft was edited for publication by staff editors of the Department's Bureau of Publications, and Artifax Corporation of San Diego prepared the *Handbook* for photo-offset production. Graphic artists of the Bureau of Publications designed the cover and drew the artwork from photos provided by Dave Richardson, Petaluma Joint Union High School District, and Phil Teeters.

The *Handbook* was published by the California State Department of Education, 721 Capitol Mall, Sacramento, California (mailing address: P.O. Box 944272, Sacramento, CA 94244-2720); was printed by the Office of State Printing; and was distributed under the provisions of the Library Distribution Act and *Government Code* Section 11096.

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Copies of this publication are available for $5.75 ($8.75 with binder) each, plus sales tax for California residents, from Publications Sales, California State Department of Education, P.O. Box 271, Sacramento, CA 95802-0271 (phone 916-445-1260). A list of other publications that are available from the Department, *Selected Publications of the California State Department of Education,* may be obtained by writing to the same address.

ISBN 0-8011-0668-0 (with binder)
ISBN 0-8011 0669-9 (no binder)

IMPORTANT TELEPHONE NUMBERS

Standard Emergency Number	911
Police/Sheriff	_____
Ambulance Source	_____
Fire Department	_____
Hospital _____ (Name)	_____
Poison Control Center	_____
School Health Service	_____
District Safety Officer _____ (Name)	_____
District/County Science Specialist _____ (Name)	_____
City/County Health Department	_____
Animal Control (Pound)	_____
_____ California Division of Industrial Relations (Safety Concerns)	_____
_____ (Contact for Chemical Disposal)	_____
_____ (Other)	_____
_____ (Other)	_____

DISTRICT EMERGENCY PROCEDURES

(Note: Insert a copy of your district's emergency procedures, such as evacuation procedures, hazardous materials spills, and so forth.)

ACKNOWLEDGMENTS

The persons listed below are acknowledged for their contributions in drafting original portions of the *Science Safety Handbook*:

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PREFACE

This publication has been prepared to help science teachers, administrators, and other school staff members understand and avoid situations in which accidents could occur in the science labs or on field trips and outdoor education experiences. No publication can or should, however, completely describe the procedures for ensuring safety under all conditions and in all situations; therefore, the authors, editorial staff, and publisher cannot be responsible for errors in publication or for any consequences arising from the use of the information published in this handbook. The suggestions included in this publication are generally agreed upon and are recommended for consideration by all California science teachers. Since this publication has been prepared for statewide distribution, not all of the recommended policies are appropriate for adoption in all districts. The ideas presented may be adapted to meet the needs of teachers and students in each district.

Since this publication is designed for use by lab instructors, it provides minimal information for students, parents, and administrators regarding the safety procedures necessary in the science laboratory. Some material, such as parental consent forms, has been included in the appendices to help teachers communicate with other audiences.

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I. INTRODUCTION

A. *Rationale for Experience-Based Science Teaching*

Laboratory activities and demonstrations represent an essential part of good science teaching. Although written materials and pictures can convey an enormous amount of information, knowledge and concepts related to science are more fully understood when students observe or participate in learning activities involving laboratory experiments and demonstrations. In addition to improving the understanding of basic science concepts, laboratory activities and demonstrations allow students to learn the processes and techniques of science laboratory investigation. Students who go to colleges and universities and take advanced science courses are expected to know laboratory procedures.

All high school graduates benefit from practicing safety procedures and from learning to appreciate scientific methods. There are potential hazards in science activities, just as there are in physical education, vocational education, and home economics classrooms. However, knowing about possible hazards and taking precautions reduces the likelihood of accidents and is the basis for creating a safe learning environment.

Science teachers must be advocates of safety and must have the information and attitudes necessary to inform and involve groups which will help support activity-based science classes. School and district administrative staff must be active supporters of hands-on science experiences. Administrators must be kept informed of the activities and concomitant safety precautions and must devote resources to make such experiences possible.

Science teachers are in a unique position to orient administrators to the attitudes, skills, rational thinking processes, and knowledge resulting from lab activities. The fact that many science lab exercises utilize readily available materials and may be inexpensive to conduct should be conveyed to administrators so that they may increase their appreciation of the number and variety of experiments. The key issue is that administrators who observe student motivation resulting from lab participation will be more likely to increase support for activities requiring more resources. For this support to be ensured, it will also be necessary to provide evidence that appropriate safety precautions have been taken.

B. *Responsibilities of Students and Parents*

Through their own educational background and training, most science teachers have learned to use safe lab techniques as a matter of course. Because many students have not had the opportunities at home and in school to observe safety procedures, the science lab is a good place to begin learning these fundamentals. Students have a responsibility to themselves and their classmates to learn and observe safety practices in all participatory science activities. Some specific areas of safety instruction for students are listed below; but in addition to such knowledge, students should adopt positive attitudes about the need for safety in a lab setting.

Students' interest in science activities must be channeled constructively so that capricious, careless actions do not occur. The following practices, skills, or knowledge areas should be taught in most laboratory classes:

- Proper eye-care safety practices
- Proper handling of glassware and glass tubing
- Proper technique for safety in working with glass tubing
- Proper setup and handling of electrical equipment
- Safe use of chemicals in the laboratory
- Correct methods for storing, handling, and disposing of surplus or deteriorated chemical substances
- Safe use of heat sources in the laboratory
- First-aid procedures
- Prompt notification to appropriate individuals or agencies of any dangerous or potentially dangerous conditions
- Safe and humane treatment of animals
- Prohibition of the use or presence of any venomous animals, poisonous plants, or plant pests
- Proper fire prevention and control techniques
- Correct methods for cleanup after experiments
- Proper behavior and courtesy in a laboratory situation
- Quake-safe behavior and evacuation routes

Parents should be aware of the kinds of science lab activities to be conducted and give their consent for participation by their children. The consent forms (see Appendix III-B-3 and III-B-4), which science teachers are encouraged to ask parents to sign, do not constitute a legal release but acknowledge that safety procedures exist at school and are part of their children's safety training. Consent forms should be considered contracts for partnership, not abdication of controls. Parents are welcome in the science labs just as in other classes (but, of course, they will have to wear protective goggles and follow other safety procedures expected of students). Parents are encouraged to support the local science program and to reinforce the curricular objectives of the course through family activities such as museum visits, field trips, etc. Parents of students participating in local science fairs should expect to work with the teacher to ensure that safety procedures are understood and adhered to.

C. *Reasonable Laboratory Class Size*

No current legal mandate prescribes special limits on class size in science laboratories. The Uniform Fire Code classifies science laboratory classes as academic subjects and specifies 20 square feet as a minimum per student as opposed to a vocational educational class which requires 50 square feet per student. Realistically, hands-on laboratory science activities require more than 20 square feet per pupil, as reflected in California Admisitrative Code, Title 2, Subchapter 4, Section 1811(g), which requires the state architect to design laboratory classrooms with 1,300 square feet of floor space (including preparation and storage space) for occupancy of 24 students. Thus, there are considerations for teachers and administrators to take into account in establishing reasonable limits on the number of students in a laboratory setting. These include: (1) the number of students that one teacher can supervise in a potentially dangerous activity; (2) the degree of personal risk; (3) the increased liability when class size exceeds 24 students; (4) the level of maturity and safety knowledge students bring to the science laboratory; and (5) the space required for each student to safely perform experiments (the National Science Teachers Association recommends 45 square feet per student). The above considerations clarify administrative responsibility for ensuring maximum safety within the science laboratory.

1. *Students*

It is difficult to set limits on laboratory class size across the board. The teacher, department head, and principal should assess the students' backgrounds relative to safety. Students who have been instructed in safety and first-aid procedures are less at risk than those without such training. The previous section (I-B) of this handbook addresses students' responsibility, and materials in the references and appendices further help to prepare students for safety. Some groups of students come to the science laboratory with safety training; these include those from previous science (laboratory) classes and many vocational education courses. Finally, some groups of students demonstrate a more mature capacity for greater responsibility, thus allowing a greater sense of security in the laboratory.

2. *Facilities*

No amount of student screening can make up for overcrowded or potentially unsafe laboratory settings. A primary concern is the physical distance between students and stations in the lab. Many school laboratory stations designed for two pairs of students add a fifth student in the aisle. This practice crowds the students and blocks traffic lanes, inviting accidents and preventing orderly evacuation and/or administration of first-aid procedures.

For the most part, laboratories were designed for a specific number of students, and this number should not be exceeded. For example, a chemistry classroom with a single vented hood was not designed so that volatile toxic chemicals might be tested simultaneously by 30 or more students; therefore, creative planning of the laboratory program is necessary. Similarly, schools with single or distant eye-wash and first-aid stations cannot accommodate multiple student emergencies, and alternative actions must be considered.

3. *Teachers*

Faculty cannot be expected to monitor an overly crowded laboratory when potentially hazardous experiments are being conducted. No one, not the students, teacher, or administrators, wants to risk having too many students in a science laboratory class. But overcrowding still happens. In cases in which a large number of students are placed in an inadequately designed facility, there are ways to provide supervisory assistance for the teacher. An obvious alternative is to add an advanced high school student, a college student, or a retired science specialist as an aide (monitor) during the potentially hazardous laboratory period. Other teachers may be willing to supervise the lab. Through alternative programming, additional laboratory sections can be scheduled to reduce class size.

Teachers are encouraged to work with their administrators to identify and alleviate potential hazards due to overcrowding and limitations in facilities. The objective should be to guarantee the safest possible environment in which to conduct experiments without reducing the number or quality of activity-based science lessons.

D. *Teacher Liability*

Laws and regulations from the national, state, county, city, and school district levels are explicit enough to place direct responsibility on teachers, administrators, and district science specialists for the safety of students in science classrooms. Today's climate of accountability and liability for

the safe conduct of educational processes places the science teacher under close scrutiny. Though protected to a degree by district legal resources, the teacher is vulnerable to professionally and personally damaging lawsuits.

It is important to plan preventive steps that will reduce both individual and district liabilities. Since districts and the classroom instructors, on occasion, may become involved in a case in which students are injured or negligence occurs, individuals should recognize that the court examines the circumstances and conduct of the responsible individuals in an effort to see if their conduct, actions, judgment, and behavior were reasonable under the given circumstances. An analysis of the actions taken by school, district, and individual determines the degree of responsibility that can be attributed to the parties involved. The court also tests individuals, using the reasonable man rule, to determine if the individual exercised the proper degree of caution and judgment that an average person of his or her training and background would have exercised under similar circumstances. Fortunately, many resources exist to help teachers gain expertise in safely conducting demonstrations and laboratory activities.

Posting safety guidelines and procedures (suggested or sample study sheets for safety with chemicals, lasers, heating, etc.) is a recommended procedure for science classrooms; but the courts have declared posting to be insufficient, in and of itself, to ensure student safety. The science teacher must also continually remind students of both general and specific hazards prior to the performance of laboratory activities in which any element of danger might exist. If a textbook or lab manual specifies a dangerous procedure, teachers must ensure that the procedure is not followed but replaced with a safe one. Students should not be allowed unsupervised access to potentially dangerous materials or equipment and should be under continual supervision in all laboratory situations (for the safety of both student and equipment). Monitoring/supervising a laboratory set-up during passing periods is an essential consideration.

Specific safety instruction and testing (see Appendixes III-A and III-A-2) are highly recommended as an integral part of every science classroom procedure. This handbook includes suggested safety procedures and a student test which may be adapted for use in the teaching of various scientific disciplines. A more specific list of precautions to avoid accidents resulting in teacher liability in chemistry labs appears as Appendix III-C.

E. *Recent State and Federal Legislation Affecting Science Instruction*

Four recent legislative enactments have had a significant impact on safety in science instruction and on the duties of science teachers. The topics of these enactments are:

1. *Hazardous Materials Education* (Education Code, Article 4, commencing with Section 49340)

2. *Schools: Removal of Chemicals* (Education Code Section 49411)

3. *Material Safety Data Sheets* (General Industry Safety Orders, Section 5194)

4. *Hazardous Materials: Release Response Plans: Inventory* (Health and Safety Code, Chapter 6.95, Section 25500)

The full texts of these laws are included in Appendixes I-E-1 and I-E-2. Summaries of the laws are presented as follows:

1. *Education Code, Article 4, Hazardous Materials Education*

This legislation recognizes the potentially hazardous nature of materials and procedures used in school science laboratories and encourages educators to increase the awareness of personnel involved to minimize the dangers.

Each school is encouraged to have a trained member of its professional staff designated as building laboratory consultant responsible for reviewing, updating, and carrying out of the school's adopted procedures for laboratory safety.

The State Department of Education should assume leadership necessary to provide qualified individuals and materials to assist schools and teachers in the development of their laboratory safety policies and procedures.

School districts are encouraged to take steps to ensure hazardous materials are properly used and stored and may request consultation services from the California Occupational Safety and Health (Cal-OSHA) Consultation Service.

2. *Education Code Section 49411, Schools: Removal of Chemicals*

The State Department of Education, in cooperation with the Division of Occupational Safety and Health shall (1) on or before July 1, 1985, prepare a list of chemicals used in school programs which includes the potential hazards and estimated shelf life of each chemical; and (2) on or before September 1, 1985, develop guidelines for school districts for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed. Each district, on or before January 1, 1986, shall certify to the Superintendent of Public Instruction whether the district is in compliance with the guidelines.

The county superintendent of schools may implement a system for disposing of chemicals from schools within the county or may permit school districts to arrange for the disposal of the chemicals.

3. *General Industry Safety Orders, Section 5194(b)(3), Material Safety Data Sheets (MSDS)*

According to Section 5194(b)(3) of the General Industry Safety Orders, laboratories not engaged in either production of hazardous substances for commercial purposes or provision of quality control analysis for production processes are partially exempt from the Act and regulation when the following conditions are satisfied: (1) all exposed employees (professional, technical, janitorial, and maintenance) are under the personal supervision and regular observation of a "technically qualified individual" who has knowledge of the physical and health hazards and emergency procedures involved; and (2) that the supervisor *conveys this knowledge to employees in terms of safe work practices*. Such a lab would be exempt from the requirement of actively obtaining a material safety data sheet (MSDS) from the manufacturer, requirements for the written hazard communication program, and actively labeling containers (except as required by other Safety Orders regarding labels). Labels and MSDSs that are received in the normal course of business, however, must be accessible to employees and may not be discarded.

4. *Health and Safety Code, Chapter 6.95, Hazardous Materials: Release Response Plans: Inventory*

This bill requires every county to implement existing law providing for governmental response to a release or threatened release of hazardous substances through a designated administering agency. (A city could assume that responsibility within its boundary.)

The bill requires any business which handles a hazardous material to establish a specified plan by September 1, 1986, in accordance with standards of the Office of Emergency Services, for emergency response to a release or threatened release of the hazardous material.

The bill requires any business which handles a hazardous material to submit a specified inventory annually to the administering agency.

II. FIRST AID

A. *General Information*

Under normal circumstances, the school nurse will direct the activities necessary for treatments of illness, injury, or other health problems of students. The situation may be such, however, that the nurse is not available for first aid on the school premises, because his or her other responsibilities may include making home calls, transporting students, and engaging in health education duties.

In the event of illness or injury to a student, it is expected that the teacher will act in an informed and objective manner with a minimum of emotional expression. It is expected that the teacher will evaluate the problem with special attention to the following areas:

- Difficulties in breathing and the starting of artificial respiration if breathing is absent. Obtain a trained person to give CPR if needed.
- The presence of bleeding and, if necessary, controlling it.
- The presence of shock and initiating management if necessary.

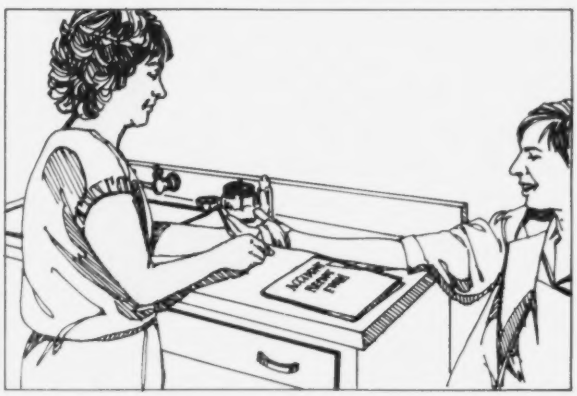
Measures should then be taken to reduce any anxiety or fear that the injured student or other students may experience. Once assistance is given, it should be continued until the problem is resolved or until the patient is released to qualified medical help, the parent, or other responsible person.

1. *Do's in First Aid*

- *Do* be cool, calm, and collected. Most cases are not serious.
- *Do* obtain staff assistance, if necessary.
- *Do* handle the person as little as possible. Do not move the person until the evaluation is complete.

Upon completing the emergency handling phase:

- *Do* check with the victim and with the witnesses regarding what happened.
- *Do* make a prompt, complete, and accurate report of the incident to the department chairperson and the administration.
- *Do* be concerned with injuries that occurred on the way to and from school as well as at school.



2. *Don'ts in First Aid*

- *Don't* give liquids (or medicines) to an unconscious person.
- *Don't* try to arouse an unconscious person.
- *Don't* incise the skin, break blisters, etc.
- *Don't* diagnose.
- *Don't* give medical advice.
- *Don't* reduce dislocations.
- *Don't* transport an injured student in a private car.
- *Don't* send a student home before consulting a parent.
- *Don't* treat injuries that happened at home.

B. *Bites Caused by Snakes, Insects, Spiders, or Mammals*

Rattlesnakes are the most common naturally occurring poisonous snakes in California. They are common in canyons, mountains, deserts, and new construction areas. Few adolescents or adults die from rattlesnake bites, though rattlesnake bites in small children are considered especially serious. Bites caused by insects seldom result in death; but the pain and discomfort may be minimized by early intervention. Dogs often come onto the school grounds and bite students, and human bites occasionally occur in schools. These bites often become infected and should be referred to a physician for treatment and continued observation.

1. *Poisonous Snake Bites*

a. The victim should be kept at absolute rest. Transport the victim to a source of medical attention as soon as possible. Treat for shock.

b. Incision of the wound is a dangerous procedure and should be undertaken only by medical professionals. An incision is a surgical procedure that should be performed by trained specialists. A sterile field and sterile instruments must be used.

c. The major effort of the teacher should be aimed at quieting the victim and effecting immediate transportation to the nearest medical facility, where an expert evaluation can be followed by the most appropriate action. Any wound that is caused by a poisonous snake and occurs on school premises would be close enough to expert emergency room help so that a teacher would not have to perform an incision.

d. Poison information centers recommend:

- Keep victim still. Transport to medical care as soon as possible.

- Place injured extremity in a lowered position to retard the flow of the toxins to the victim's heart.

- If bite is on arm or leg, apply constricting band 2-4 inches (5-10 cm) above wound. Band should be snug but loose enough to allow blood to flow to limb.

- Cool extremity with cold compresses if possible until person arrives at hospital; but do not pack the wound in ice.

- Do not cut wound area if injured person is within one hour of being admitted to emergency room.

2. *Insect/Spider Stings and Bites*

a. Remove stinger, if present, by scraping.

b. Use cold application and apply soothing lotions such as calamine.

c. Refer student with black widow spider bites to nurse and parents for medical attention. Generally, these are not considered to be medically urgent unless alerted otherwise by the school nurse that student has had an allergic reaction.

d. Information centers recommend the following action for bee stings:

- Observe person for allergic reaction. Some of the signs to look for would be:

  - Difficult breathing
  - Dry, hacking cough
  - Swelling and itching about the eyes
  - Sense of constriction in throat or chest
  - Massive rash
  - Sneezing and wheezing
  - Sense of uneasiness

  These symptoms usually occur within five minutes, and such victims should be seen by a physician right away. Occasionally, these reactions are delayed.

- Remove the stinger by scraping it with fingernail or blunt edge of knife. To avoid releasing more venom, do not squeeze end of stinger by pulling it out with your fingers.

- Wash area of sting well with soap and water.
- Cover sting with moistened meat tenderizer containing the enzyme papain. (Check ingredients on the label for word "papain.")
- Place ice pack on sting or submerge in ice water. Do not put ice directly on the skin. Use ice bag or wrap ice in cloth.
- If swelling becomes severe, see your physician for further evaluation and medications. Observe for infection, especially if stung by a wasp or yellow jacket, both of which are known to carry bacteria.

3. *Mammal Bites*

There is danger of infection and rabies from bites of all warm-blooded animals. Students should be advised to leave strange dogs and other animals alone, especially a familiar pet that is acting peculiarly. Bats and skunks active in daytime must be considered rabid.

First-aid treatment consists of washing and flushing out the wounds thoroughly with strong warm soap or detergent solution as quickly as possible. Continue the washing for at least ten minutes. The value of this procedure is greatest when performed during the first hour or two. A dressing is generally not needed. Refer to parents for medical follow-up. Catch the animal, if it is deemed safe to do so, and obtain information on the animal. Then call the local animal control agency.

C. *Burns*

As heat sources and/or corrosive chemicals are used in many laboratory science activities, there is the potential for burns from either to occur. In the event of such occurrence, the following procedures are appropriate:

1. *Chemical Burns of the Skin* (usually from strong acids or alkalies)

This type of burn needs washing with large amounts of water. Use a shower or hose at low pressure, if available, for at least five minutes. Remove clothing from the affected area. Some chemical containers may suggest other helpful first-aid measures on the label; these may be used for that particular chemical. Do not attempt to neutralize any chemical; to do so may cause further chemical reaction and more damage. Apply dressing and obtain medical aid utilizing the serious injury or illness routine.

2. *Chemical Burns of the Eye*

See First Aid, Section D of this section of the handbook, p. 11.

3. *Nonchemical Burns of the Skin*

The degree or extent of burns and the percentage of skin surface involved usually determine the first-aid measures used. In general, adults who have suffered burns over 10 percent of their body surface (a child, 2-10 percent) require hospitalization. Burns to the face suggest possible injury to the respiratory tract and obstructed breathing as facial swelling increases. *Prompt medical attention is imperative.*

First-degree burn means a minor burn, such as those resulting from overexposure to the sun or from light contact with a hot object. The usual signs are redness or discoloration along with mild swelling and pain. First aid includes cool water applications or submersion of the burned area in cool water and application of a dry dressing if necessary.

Second-degree burns may result from a very deep sunburn, contact with hot liquids, or flash burns from flammable products. They are usually of greater depth than first-degree burns and have a red appearance. Blisters are usually present. First aid for second-degree burns includes: (1) immersion of the burned part in cool water (not in ice water) for a few minutes (room temperature or less is appropriate); (2) cleansing thoroughly with soap and water; (3) removal of ruptured blisters; (4) application of dry, sterile gauze

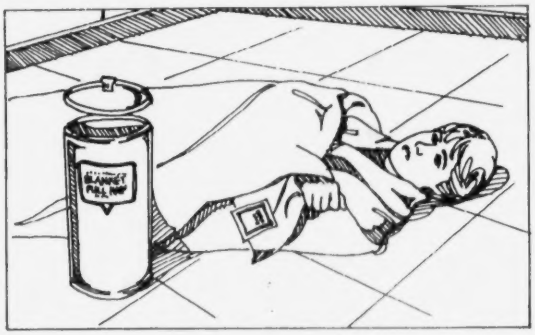
or clean cloth as a protective bandage; (5) precautions against breaking intact blisters or removing tissue; (6) avoidance of an antiseptic preparation, ointment, spray, or home remedy if the burn is severe or covers more than 10 percent of body; and (7) keeping affected arms or legs elevated.

Third-degree burns may be caused by a flame, ignited clothing, immersion in hot water, grease scalds, contact with hot objects, or electricity. The temperature and duration of contact are important in determining the extent of tissue destruction. They are usually characterized by deep tissue destruction; white, dark brown, mottled, or charred appearance (at first, the burn may resemble a second-degree burn); and complete destruction of all layers of the skin. First aid for third-degree burns includes the following:

- Remove any clothing that may be still smoldering. Do not apply ointments, commercial preparations, grease, or other home remedies, as such substances may cause further complications and interfere with treatment by the physician.
- Cover patient with a blanket.
- If the hands are involved, keep them above the level of the heart.
- Keep burned feet or legs elevated. (The victim should not be allowed to walk.)
- Elevate slightly the head of a victim with facial burns. Keep them under continuous observation for breathing difficulty. If respiration problems develop, an open airway must be maintained.
- Avoid immersing an extensively burned area or applying ice water over it, as cold may intensify the shock reaction. Cool water may be applied to the burned area.
- Obtain medical assistance immediately, utilizing the serious injury or illness routine provided for in emergency procedures.

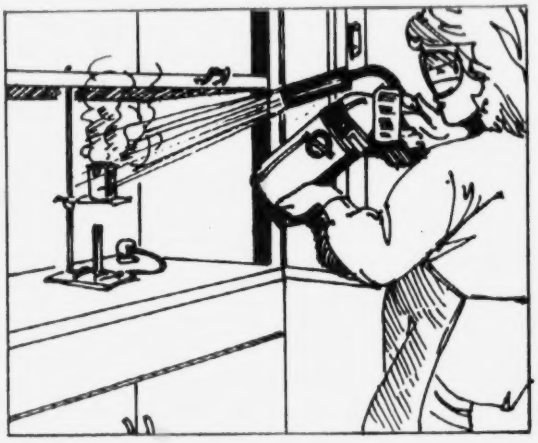
4. *Fire Blanket*

Students whose clothing catches on fire should not run. They should stop, drop, and roll on the ground immediately as another student brings the fire blanket. Then he or she should roll up in it to smother the flames. The blanket should be held close at the neck and the flames forced away from the head and hair as the student rolls up in the blanket.



5. *Fire Extinguisher*

Hands-on training is recommended by the NIOSH publication, *Safety in the School Science Laboratory* (1977). The instructor and students should be familiar with the operating instructions for all extinguishers in the laboratory. They must be positioned near enough to procure and use without delay—generally 75 feet (23 m) or less. The labels on the extinguishers contain directions for their use.



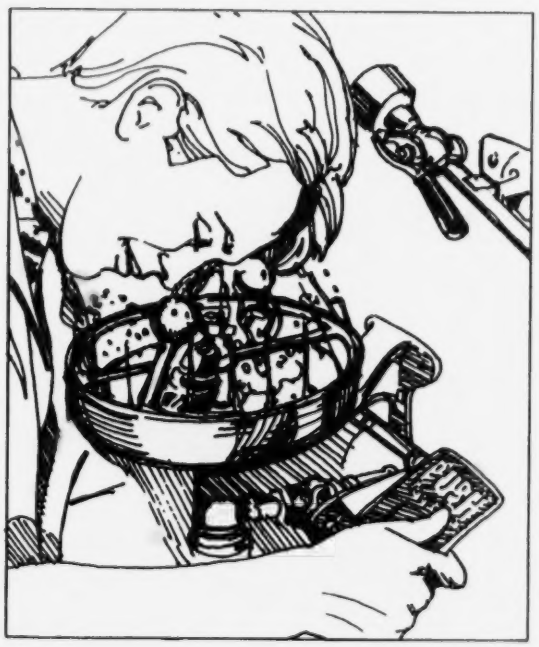
D. *Eye Treatment*

Immediate first-aid treatment for eye injuries may save the eyesight of an injured student.

1. *Eye-Wash Station*

An eye-wash station should be provided in any classroom/stockroom where chemical splash into eyes is a possibility (General Industry Safety Orders, Section 5162, c; See Appendix I-E-1). Several types of stations are possible:

- A completely plumbed in, self-contained eye and face wash station.
- A squeeze handle-operated face-and-shower head on a hose that pulls out of the counter and is installed next to an existing sink over which the face can be held as the eyes are washed.
- On a temporary basis, one classroom sink at which a rubber hose is installed on the end of the faucet. Adjust the water volume control under the sink so that even if the faucet is turned all the way on, no damage to the eyes can occur.



2. *Chemical Exposures to the Eye--Acid Burns*

Begin first aid for acid burns of the eye as quickly as possible by thoroughly washing face, eyelids, and eye for at least 15 minutes with tap water. If victim is lying down, turn head to the side, gently hold eyelids open, and pour water from the inner corner of the eye outward. Make sure that the chemical does not wash into the other eye.

- Cover the eye with a dry, clean protective dressing (do *not* use cotton) and gently bandage in place.
- Caution victim against rubbing the eye.
- Have the victim transported to an ophthalmologist's office or a hospital emergency room for further evaluation and treatment.

3. *Chemical Burns of the Eye--Alkali Burns*

Alkali burns of the eye are progressive injuries. An eye that first appears to have only slight surface injuries may develop deep inflammation and tissue destruction, and eyesight may be lost. Flood the eye thoroughly with water for 15 minutes. If victim is lying down, turn head to the side. Gently hold lids open and pour the water from the inner corner outward. Make sure the chemical does not wash into the other eye.

- Cover the eye with a dry, clean protective dressing (do *not* use cotton) and gently bandage in place.
- Caution victim against rubbing the eye.
- Take the victim to an ophthalmologist or emergency room for further evaluation and treatment.

4. *Other Chemicals in the Eye*

- Hold eyelids open, wash eyes immediately with gentle stream of running water, and continue for at least 15 minutes. Make sure that the chemical does not wash into an unaffected eye.

- Have someone call the poison control center to ascertain the need for further medical treatment. (See list of poison control centers in Appendix II-E-2, on page 118.)

E. *Exposure to Potential Poisons*

Proper storage and safety precautions, including correct labeling of all containers (see page 38) are effective in preventing poisoning and should be followed. The danger of poisoning is present, and the teacher must be ready to act immediately.

The accidental consumption of chemical poisons in the classroom, though rare, is a distinct possibility. It is advisable to maintain a policy of not tasting or placing any substance in the mouth except as vital to the learning situation and under closely controlled conditions. Careful direction should be given in the use of pipettes. Suction devices, not the mouth, should be used when pipetting all chemicals, especially radioactive materials and poisons. Label all chemicals. If the labels are lost, notify the proper authorities for disposal.

1. *Inhaled Poisons*

- Carry victim (if possible, do not let him or her walk) to fresh air immediately. Open all doors and windows if victim is too big to carry.
- Loosen clothing.
- If victim is not breathing, use mouth-to-nose or mouth-to-mouth rescue breathing, and/or CPR. Be sure not to inhale patient's breath. Don't stop until patient breathes or help arrives.
- Have someone else dial 911 on the telephone for emergency medical assistance.
- See treatment of shock (Section G, p. 14).

2. *Ingested Poisons*

a. Poison control centers are available to assist in evaluating the potential health risks from an exposure and the need for first aid and further medical management or evaluation. (See list of poison control centers on page 118, Appendix II-E-2).

b. The poison control center should be provided with the following information:

- The age of the victim
- The name of the poison involved
- The amount or degree of exposure
- The condition of the victim
- Any first aid that has been performed

The center staff will provide detailed instructions as to what additional steps are needed.

c. If at any time the victim loses consciousness or develops difficulty in breathing, emergency medical personnel should be summoned by dialing 911. Rescue breathing and/or CPR should be performed, if needed.

d. Syrup of ipecac should be available to induce vomiting if indicated. However, it should not be administered unless instructions are provided by the poison control center or a physician.

e. If instructed to take the victim to a doctor or medical facility for further evaluation and treatment, bring the package or container of the ingested poison with intact label(s) as well as any vomited material.

f. If there is any delay in the above procedures, the patient may be allowed to rinse out his or her mouth with water. A *small* quantity of water (2 to 4 ounces [60-120 ml]) may be swallowed to relieve any localized irritation in the throat or esophagus. It is *no longer* considered appropriate to give 8 to 16 ounces (240-480 ml) to dilute the poison in the stomach unless a stomach tube is in place and suction (aspiration) is proceeding. Dilution of the poison will sweep the poison out of the

stomach (through the pylorus) and beyond the reach of the emergency room gastric pump.

g. Notify the parent(s)/guardian(s) and arrange to meet child at hospital.

3. *Food in Science Department Refrigerators*

Food for human consumption should never be stored in refrigerators used for the storage of chemical reagents or biological materials. The chances of contaminating the food are too great to allow this practice. Also, there is no reason to add the danger of ingesting toxic materials to the many hazards which already exist in a high school science laboratory.

Food should never be eaten in science laboratories because of the danger of accidentally ingesting toxic chemical compounds. Individuals do not ordinarily willingly ingest hazardous substances, so this problem can be controlled by not allowing the consumption of food and drink in the laboratory.

4. *Poison (Chemicals) on Skin*

- Remove any clothing with chemicals or poison on it.
- Wash skin with large quantities of cool running water.
- Call poison control center to determine need for additional treatment (Appendix II-E-2, page 118).

5. *Poison Oak*

Poison oak is common in wooded areas throughout California. The skin rash some people develop when they come into contact with poison oak sap is called allergic contact dermatitis. Exposure to it once can cause an allergic tendency, or it may take repeated exposure for skin cells to become sensitized. Once the skin is sensitized, a rash develops whenever contact is made with the sap again. Not all people develop allergies to these plants, and sensitivity varies among individuals.

It is not necessary to touch the plant to develop a rash; the sap can be carried by clothes, tools, pets, and even by the smoke from the burning plant.

Initially, the rash is red and itches. Blistering may occur later. If the rash spreads, some sap has remained on the skin (or reexposure has occurred) because the serum from existing rashes does not spread the rash.

The treatment for exposure to poison oak is as follows:

- Wash all exposed surfaces with soap and water.
- Wash all clothes, shoes, belts, bedding, and animals exposed.
- *Do not* use calamine lotion over area.
- Use wet soaks with tepid water for 20-30 minutes every two hours.
- Use baking soda paste to reduce the itching.
- See family physician for diagnosis and suggested management.

F. *Cardiopulmonary Resuscitation (CPR)*

This procedure must be administered by someone who has been trained according to the standards of the American National Red Cross or the American Heart Association.

Basal life support is an emergency first-aid procedure that consists of the recognition of airway obstruction, respiratory arrest, and/or cardiac arrest and the proper application of cardiopulmonary resuscitation (CPR).

The CPR procedure consists of:

- Opening and maintaining an open airway
- Providing artificial ventilation by means of rescue breathing

- Providing artificial circulation by means of external heart compression

Each science teacher should be familiar with the CPR procedure because experience has shown that a stoppage of breathing is seldom isolated from a heart stoppage. Even if normal breathing and heartbeat are not restored, the injured person can be kept alive by this procedure until expert medical assistance is available.

Any condition requiring CPR is a serious medical emergency. During its execution, another staff member or responsible individual should be notifying the parent and having the nurse send for an ambulance (police/ sheriff, see inside front cover). The ambulance crew is especially trained for such emergencies and carries hospital emergency room equipment. Whenever the ambulance departs, the hospital emergency room to which the patient is being carried should be alerted by school staff so that all personnel and equipment can be awaiting the arrival of the ambulance.

G. *Recognizing Shock*

Shock from injury is also called "traumatic" shock. Body functions are depressed and death may result even if injuries would not otherwise be fatal. (See Section II-H for Treatment of Shock.) Look for:

- Pale or bluish skin. (In a dark-skinned victim, check mucous membranes inside mouth or under eyelids.)
- Moist or clammy skin.
- Rapid pulse, often too faint to be felt at wrist.
- Increased breathing rate. Shallow if there is chest or abdominal pain.
- Weakness. If due to hemorrhage, victim may also be restless and anxious. Will complain of deep thirst.
- Retching or vomiting.
  - If patient has vomited, save sample.
  - Do not give fluids; do not induce vomiting in unconscious person. If victim is vomiting, turn head so that material drains.

H. *Treatment of Shock*

The symptoms of shock are fainting or collapse, or cold, pale, sweaty skin. Treatment of shock consists of:

- Keep victim lying down.
- Cover victim to minimize further loss of body heat.
- If victim stops breathing, use mouth-to-nose or mouth-to-mouth rescue breathing (and/or CPR).

III. LABORATORY SAFETY PRECAUTIONS

A. *General Information*

The laboratory science instructional program should be carefully planned and conducted so that maximum safety conditions will be provided for all personnel. Teachers having specific concerns about safety conditions related to facilities, equipment, supplies, curriculum, classroom occupant load, etc., should notify their site administrator *in writing* immediately for assistance in relieving the condition.

A listing of safety practices and regulations common to all science laboratories is found below. Lists of additional laboratory and safety practices for specific subject areas and teaching situations are included in following subsections.

- Teachers must be fully acquainted with the first-aid procedures, treatment, and regulations included in Section II of this publication.
- Teachers must have a thorough understanding of the potential hazards of all the materials, processes, and equipment that will be used in their school laboratory.
- Teachers should know and have prepared in advance chemicals to neutralize any dangerous materials used by students.
- Teachers must report any student injury or accident immediately on their district's accident report form, available in the main office or health office of each school.
- Safety in the laboratory should be taught throughout the year. Thorough instruction on necessary safety procedures must precede each laboratory activity. (Sample classroom safety regulations, a sample student safety contract, and a sample student laboratory safety test for initial instruction are included in Appendix III-A.)
- The use of approved eye protection devices must be required of all persons performing science activities involving hazards to the eyes. All persons in dangerous proximity to a laboratory activity must also wear approved eye protection devices. (Read carefully in Section IV-C, page 80, of this publication, the passage entitled Eye Protection.)
- Reagent and storage bottles containing chemicals should be properly labeled at all times (including date of receipt or preparation).*
- Poisons and dangerous reactants should be made inaccessible to students except during actual usage.
- Chemicals should be stored according to their compatibility group.
- Chemicals should not be stored directly on the floor. This precaution will prevent contact with water from flooding, mopping, condensation, or the puddling of liquid contents of defective or broken containers around adjacent stored chemicals. Large containers should be stored on the lowest shelves to minimize the danger of breakage or spillage when being removed or replaced.
- Any known carcinogen (see p. 36) must be removed from the science area and disposed appropriately.

  NOTE: Asbestos, once used in the manufacture of pads, wire gauze centers, beaker tongs, gloves, and various other products, must be replaced by ceramic fiber or glass fiber products unless the asbestos fibers are permanently bonded in a hard sheet as in the commonly used building material.
- In an experiment or demonstration involving any flammable liquid (such as alcohol), care must be taken that any flame in the room is an

*Minimum precautionary labeling standards for injurious substances used in places of employment in California are established in Title 8, California Administrative Code, Article 112, "Labeling of Injurious Substances." The label standards which are of special concern to high school science teachers are included in Section III-C-6, page 38, of this handbook.

absolutely safe distance from the volatile liquid. Vapors may even flow along a table or countertop for long distances and then flash back. Beware of gas water heaters in or near science classrooms.

- Teachers should be familiar with the location of all master controls for utilities, especially the master valve in each room for the gas outlets. Mark and/or color-code all services clearly.

- The instructional area should be kept free of spills, broken glass, and unnecessary equipment and materials. Good housekeeping is essential.

- Stone crocks or plastic containers should be provided for the disposal of dangerous waste chemicals and solid materials. Three different waste receptacles should be provided for: (1) broken glass; (2) spent matches; and (3) waste paper. Arrangements should be made for further disposal of the waste chemicals in accordance with the Solid Waste Disposal Act at an appropriate dump site for hazardous materials. (See Section III-C-5, step 6, page 34.)

- Teachers should avoid unsafe practices by instructing and cautioning students regarding the correct techniques for:

  - Use of a Bunsen burner and/or other related flame-producing equipment
  - Heating of liquids in test tubes, beakers, and crucibles
  - Handling of reagent bottles
  - Use of polyethylene squeeze bottles
  - Obtaining and handling of dry chemicals
  - Filtering
  - Cutting, bending, and fire-polishing of glass tubing and rods
  - Use of other laboratory materials as appropriate; e.g., pipettes

- When an electrical plug is to be removed from its socket, the plug, not the electrical cord, should be pulled.

- Laboratories should be locked at all times when not in use.

- The custodial staff should be alerted to general hazards they may encounter in science areas and to special situations that arise.

- An example for the students should be set. Follow all safety regulations and constantly alert and remind students of hazards. (For example, wear goggles when students are required to do so.)

- Periodic use should be made of the "Safety Checklist for Science Instruction, Preparation, and Storage Areas" as a self-check of classroom and preparation areas. (See Appendix III-A-2.)

Science teachers should be aware of the requirements of Education Code Section 32030 concerning the use of eye protective devices in classrooms. They should also be familiar with the section of this publication pertaining to eye protection. Many of the hazardous activities listed here are of interest to science teachers in junior high school and teachers of general science courses in grades nine through twelve. Particularly important to teachers of these courses would be the following information:

- Investigations in geology and earth science frequently involve activities such as hammering, chipping, and grinding rocks, minerals,

and metals. When hammering or chipping is done, the use of eye protective devices as well as a cloth covering over the rock or mineral to reduce the hazards from flying particles is absolutely necessary. When grinding rocks, use a face shield for protection.

- No homemade eye protection has been approved for use when the sun is being viewed. Therefore, students may not participate in this activity unless images of the sun can be projected or can be viewed with a commercial telescope with a filter. The viewfinder of any telescope should not be used during an activity involved with viewing the sun unless the viewfinder is especially designed for that purpose. Avoid eye injury which may result from accidentally tripping the mechanism and engaging the viewfinder. To do so, place tape on the bracket supporting the mirror for the finder in such a manner as to shade the mirror. Teachers must closely supervise all such activities in which a telescope is used.

- Students must not look directly into the sun, even during complete solar eclipses. The danger of retinal burn comes from the invisible infrared rays which penetrate light filters and instantaneously damage eyes. The retina is not sensitive to pain; therefore, the victim might not immediately be aware of eye damage. Retinal burns are incurable and destroy the field of fine vision. The victim's ability to read can be lost forever.

- Layers of photographic film or welders' masks should not be used to look directly into the sun, even during a complete solar eclipse.

- The indirect pinhole method should be used. A simple projector for observing the eclipse can be made with two pieces of white cardboard. A pinhole or pencil point hole in the top piece serves to project and focus the image of the eclipse on the second piece. The size of the image can be changed by altering the distance between the two pieces of cardboard.

- When using infrared and ultraviolet light sources, observers must shield themselves from direct view.

B. *Safety in the Biology Laboratory*

In addition to the following safety practices, biology and physiology teachers should be familiar with all other sections of the handbook pertinent to their instructional program. Special attention is directed to the Biological Science Laboratory Regulations (Appendix III-B-3).

- In experiments requiring special biological substances such as nicotine alkaloid, care should be taken that the use of such materials is carefully supervised.

- The use of drugs and hypodermic needles must be limited to those specifically called for in the instructional program and for specific projects under close supervision of the instructor. Keep all such drugs and hypodermic equipment in a safe, locked place.

- Radioactive materials used in biological research should be properly marked and, when not in use, appropriately secured. (See Appendix III-B-3.)

- Volatile solvents, such as acetone used in paper chromatography experiments, should be used only in an area that is well ventilated or where a fume hood is available.

1. *Human Blood Sampling*

   - If blood typing or other microscopic analysis of fresh human blood obtained from individual students *is permitted* and is to be conducted in the classroom, it must be done:

     - On a voluntary basis

     - Preferably only by those student volunteers who bring a permission note signed by a parent

     - By the volunteer, from herself or himself

   - Several days before the opportunity for voluntary blood sampling by students is to be provided, discuss with the students the techniques and anticipated learnings. Emphasize that for most students this is a perfectly safe procedure and discuss the risks for hemophiliacs, hepatitis patients, etc. Emphasize also that the results of their tests are not to be considered valid for diagnostic purposes.

Explain to the class that students with any known medical problem, especially any of the following conditions, must *not* participate in this activity:

- Diabetes

- Excessive bleeding (hemophiliac or user of prescribed drugs, such as Coumadin, that lengthen clotting time, e.g., for heart conditions)

- Hepatitis (in the last year). If Australian antigen hepatitis is involved, a student may still be a carrier and could infect other students from contact with table tops, broken lancets, etc.

- Chronic pyoderma (skin pus areas, recurring boils). Students with this condition would likely have staphylococcus and streptococcus bacteria all over their skin, causing reinfection or infection of others.

- Exposure to the AIDS (acquired immune deficiency syndrome) virus. The blood can transmit the virus from an infected individual to another if the virus gains entrance into the blood of that other person.

Students with any medical problem such as the above do not need to tell the teacher or their classmates; they simply would not bring to school a note from their parents giving permission. Thus, they need not be embarrassed about their medical problem.

- The danger of spreading infectious diseases such as hepatitis makes it necessary that only sterile techniques be employed.

- Care must be exercised that only new, individually packaged sterile lancets be used one time only and then discarded properly. Dipping a used lancet in alcohol *does not* provide sterilization. Contact

your local county health department for proper disposal procedures.

- If there are several students in one class period who wish voluntarily to draw blood samples for use by themselves or other class members, it is necessary that each student drawing a sample have a separate sterile lancet, which is to be used to make only one puncture.

- The surface of the finger from which the blood is to be withdrawn must be rubbed with absorbent cotton dipped in alcohol before puncturing the skin and rubbed again with a fresh piece of cotton, dipped in alcohol, after removing blood.

- The use of disposable lancets meets the requirements for this activity. Each lancet should be used only once, by and for one person; and then the point must be carefully and deliberately broken or bent back and discarded.

2. *Epithelial Tissue Study*

- Great care should be exercised by students in obtaining epithelial cells from the inside of the cheek for study under the microscope. Only the blunt edge of a toothpick should be used. Pointed instruments or any part of a scalpel should *never* be used for this purpose.

- This experiment would preferably be conducted only by those student volunteers who bring a permission note signed by a parent.

3. *Osmosis Experiments*

- In the typical osmosis experiment, care should be exercised in inserting the thistle tube through the rubber stopper.

- The thistle tube should not be grasped by the bowl. Instead, grasp the tubing of the thistle tube near the rubber stopper.

- A lubricant, such as water, glycerin, or liquid detergent should be used.

- A towel should be used to protect the hands.

4. *Bacterial Experiments*

- Pathogenic bacteria should not be cultured. Fortunately, these harmful bacteria do not readily grow except at a temperature approximately that of the human body and on enriched media, such as blood agar. It is unlikely that nutrient agar or potato agar will grow disease-producing bacteria, except that molds producing valley fever and histoplasmosis, in addition to anthrax bacteria, are found in soil in many areas and will grow in nutrient agar. Thus, culture plates should not be inoculated with soil unless the plates remain sealed and are sterilized before disposal.

- Petri dishes passed around the classroom for inspection of cultures should be bound together with transparent tape.

- Wire loops used for transferring bacteria cultures should be flamed after each transfer is made.

- Inoculating loops must be used with care. The film held by a loop may break and cause substantial atmospheric contamination. A hot loop, when inserted into a liquid, may cause spattering. When a contaminated loop is inserted into a flame

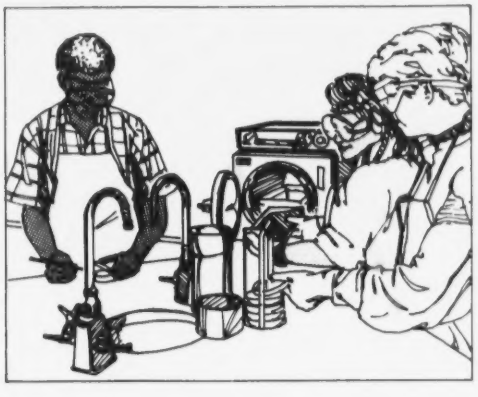
for sterilization, an aerosol may be generated by the boiling and volatilization of the material before the flame can kill all pathogenic microorganisms.

Liquid cultures should never be agitated by inoculating loops because of the possible production of aerosols. Loops should be allowed to cool before insertion into liquids. This procedure may require the use of more than one loop so that as one is being used, others are cooling.

Whenever inoculating loops are being used, any actions that might result in the generation of an aerosol--jerky movements, shaking of the loop, agitating liquids--must be avoided.*

These precautions were intended for laboratory activities involving pathogenic bacteria. Since pathogenic bacteria should not intentionally be cultured in the high school laboratory, such extreme precautions should not ordinarily be necessary. However, maximum precautions may provide experience valuable in university work or technical occupations. Any instructor or student suspecting the presence of pathogens should, however, take special precautions.

- To sterilize plates when the possibility of pathogenic organisms is suspected, you should:



- Autoclave the unopened plates in the usual manner. Usually, 15 lbs./in.^{2} for 15 to 20 minutes kills the majority of microbes. However, if you are trying to sterilize soil samples or large volumes of pathogens, then continue with this program described below.
- Wait one day for any resistant spores to leave the resting stage and begin to grow.
- Sterilize a second time.
- Wait one day.
- Sterilize a third time.
- All resistant spores should by now be killed. The plate may be safely opened for cleaning or discarded in the regular trash.

5. *Operation of Pressure Cooker for Sterilization*

   - Before operating the pressure cooker, the teacher should be familiar with the proper directions for its operation.

*National Institute for Occupational Safety and Health, "Safety in the School Science Laboratory," in *Instructor's Resource Guide* (Cincinnati, Ohio: Division of Training and Manpower Development, 1977), Lesson 10, pp. 12-13.

- The safety valve should be examined to make sure it is in working order.
- The gauge pressure should be kept at or below a maximum of 20 pounds per square inch.
- The pressure should be returned to zero before the cover can be safely removed.
- The test stopcock should be opened before the clamp can be safely released.
- An eye protection device should be used when working with cooker under pressure.

6. *Extraction of Chlorophyll, Using Flammable Solvents*

- An electric heater of the immersion type or a water bath heated by an electric hot plate should be used.
- An open-flame-heated water bath for heating the alcohol or other solvents should *not* be used.
- Flames should be kept away from solvents or vapors. If solvent ignites in the beaker, cover the beaker with glass plate to extinguish the fire. If burning solvent is spilled on the table, use either the carbon dioxide (or 2A-10BC dry powder) fog extinguisher or the fire blanket. These devices should be kept readily available.

7. *Use of Dissecting Instruments and Specimens*

- Students should be instructed in the safe use of dissection instruments. Special care should be taken to avoid cuts or scratches when cleaning scalpels and needles.
- Specimens should be obtained which, although originally preserved in formalin, have been shipped in alternative low toxicity preservatives.
- Preserved specimens should be thoroughly washed (including the abdominal cavities of large specimens) before being handled by the students. When specimens are removed from preservation solution, rubber gloves should be worn, or forceps or tongs should be used, depending on the size of the specimen. Use eye protection devices to protect against splash and fumes.
- Preservative fumes may be irritating to the eyes, nose, and throat. Adequate ventilation should be provided whenever preservative fumes are present.
- Approved goggles must be worn during dissections.
- Preferably, dissections would only be carried out by students that have obtained a permission note signed by a parent.

8. *Use of Microscopes and Hand Lenses*

Students with eye infections should not be allowed to use microscopes or hand lenses.

9. *Handling Laboratory Animals*

- Heavy rubber or leather gloves should be worn when handling live animals. (Be sure gloves are readily available.)
- Students and visitors should be cautioned about the dangers of inserting fingers into an occupied animal cage.

- "Keep Hands Off" signs should be conspicuous on cages housing animals which may bite.

- Students should be trained to handle rats, mice, guinea pigs, and other animals gently so as not to excite the animals (e.g., poking pencils at animals encourages biting behaviors). Hamsters are not recommended for classroom use, because they are nocturnal and are more likely to bite during daylight hours.

- Poisonous animals should *not* be brought to or kept at school.

10. *Insect-Killing Jars*

For science projects or for study in the classroom, students will need to be familiar with the best way to collect and preserve insects. A safe killing jar can be made by using any clean, large, screw-type lid jar (mayonnaise jars are quite acceptable). A facial tissue is placed in the bottom to absorb the killing liquid. Several liquids can be used to provide the lethal fumes, including ethyl acetate or ethyl alcohol. (Under no conditions should carbon tetrachloride or potassium cyanide be used in insect-killing jars.) The killing liquid is added to the tissue in the bottom of the jar; about six drops are generally satisfactory. A clean tissue is placed on top of the tissue containing the liquid to keep the insects dry. The jar must be labeled properly and include the following information: DANGER. FLAMMABLE. POISONOUS FUMES. DO NOT BREATHE.

It is a simple task to recharge the jar with lethal fumes by removing the top tissue and adding a few more drops of the killing liquid. A clean tissue is then added, and the jar is again ready for use.

An alternate method of preparing insect-killing jars is to:

- Place 1 inch (2-3 cm) of freshly prepared plaster of paris in bottom of glass jar (the smallest size necessary).

- Pour enough ethyl acetate to cover the plaster of paris at least 12 hours before use.

- Let stand for 20 minutes, then pour off the excess. Enough ethyl acetate will be absorbed by the plaster of paris to last a week if covers are kept in place.

- Use tissue to cover the plaster of paris during use.

The students must be adequately instructed in the use and proper construction of insect-killing jars.

C. *Safety in the Chemistry Laboratory*

In addition to the following safety practices, chemistry teachers should be familiar with all other sections of the handbook pertinent to their instructional program. Special attention is directed to the section entitled "Laboratory Safety Precautions, General Information," page 15, and "Chemistry Laboratory Legal Safety Checklist" (Appendix III-C).

1. *Laboratory Precautions*

- Care must be taken to give proper instruction and caution regarding the use of polyethylene squeeze bottles and dropping bottles, especially if the bottles contain flammable liquids. In this case bottles should not be used around open flames.

- On inserting glass tubing into rubber stopper or tubing, observe the following precautions:

  - Never attempt to insert glass tubing having a jagged edge. Fire-polish, if possible. Otherwise, bevel the edge with a file, wire gauze, or emery cloth.

  - Use water, soap solution, glycerin, or petroleum jelly as a lubricant and gently press the tube into the hole by a twisting motion.

  - Always aim the glass tubing *away* from the palm of the hand which holds the stopper or rubber tubing.

- Expand the rubber stopper, using a #3 cork borer prior to insertion. Lubrication is still necessary.

- Always hold glass tubing as close as possible to the part where it is entering the rubber stopper.

- Lessen the chance of injury resulting from broken tubing through the use of a cloth wrapped around the hand or the tubing at the point of contact with the hand.

- Do not grasp the thistle tube by the bowl when inserting a thistle tube into a rubber stopper. Grasp only by the tubing as close as possible to where the glass tubing enters the stopper. Always lubricate the tube and use a twisting motion when applying pressure.

- Exercise care so that long hose connections between burners and gas outlets are protected from pinching or being pulled away from the outlet.

- Use the stationary or portable fume hood when potentially hazardous vapors or gaseous substances are used or produced in science laboratory activities.

Whether permanent or portable, fume hoods must meet certain criteria:

- Average face velocity of 100 linear feet (30 m) of air per minute with a minimum of 70 linear feet (21 m) per minute, at any velometer position.

- Placement so that air currents do not draw fumes from hoods into the room.

- Provision of a standpipe extending seven feet (2.1 m) above the roof and located so that fumes will not be drawn into windows or air intakes.

- Standpipes constructed of corrosion-resistant materials. Local fire codes must be checked for standpipe specifications.

- Fume hoods are never to be used for storage of books, supplies, or chemicals. They are an item of safety equipment. Air velocity should be checked with a velometer or a single piece of tissue paper, which should stand straight in when held in the opening with the hood operating.

- The stationary or portable fume hood should be used whenever obnoxious or poisonous fumes are produced.

- Dry ice can be preserved for short periods of time by wrapping the ice in several layers of newspaper to insulate and reduce rate of sublimation. The use of vermiculite, styrofoam beads, or other particulate insulating material and a styrofoam chest will further extend the preservation of dry ice. Dry ice should be handled with great care to avoid contact with the skin and eyes.

- Glass wool and steel wool should be handled carefully to avoid getting splinters in the skin or eyes.

2. *Students' Safety Precautions*

- Students in the proximity of the experiment should be wearing goggles and

should be evacuated from seats near the demonstration table even if the possibility of injury is remote. Injury might occur from the spattering of chemicals, inhalation of fumes, etc.

- Students should be familiarized with the potential hazards of various chemical substances on the list contained in the section entitled "Potentially Hazardous Chemicals Found in Laboratory Supplies," page 42.

- To smell the contents of a test tube or other container, students should be instructed to wave some of the escaping vapors towards themselves. The container should never be brought up close to the nose.

- Never cap or use a solid stopper in a bottle containing dry ice or cryogenic liquids. Always plug loosely with cotton or use a stopper with a hole.

- Students should be reminded that chemicals should never be tasted, smelled, or touched unless such action is approved by the instructor and conducted in the proper manner.

3. *Teachers' Safety Precautions*

- Demonstrations involving potentially explosive substances must be arranged to shield both pupils and teachers from any danger. The teacher and students should use goggles, face shields, and safety shields for protection. Size of apparatus and quantities of reagents used in demonstration should be consistent with safety; i.e., preparation of H_2, Cl_2, Br_2, I_2, P_4O_{10}, CO, etc.

- Water should never be added to concentrated acids. To dilute acids, add the concentrated acid in small quantities to the water, stirring constantly. Use heat-resistant glassware for this procedure.

- Table tops should be protected from extreme heat by using insulation under burners or heated objects. Do not use asbestos insulation unless fibers are bonded in a hard material such as the frequently used building boards. Broken or chipped boards should be discarded.

- White phosphorus (if absolutely necessary for the program) must be kept under water. This form must also be cut under water. If cut in the open air, the friction may be sufficient to ignite the material, with dangerous results. It is recommended that white phosphorus be disposed of and red amorphous phosphorus be used if required.

- Red amorphous phosphorus should be made available for student use only in small quantities. When phosphorus burns, it produces toxic phosphorus pentoxide. Red phosphorus fires are very difficult to extinguish. Red phosphorus resublimes as white phosphorus.

- After receiving approval from your local air quality regulatory agency, residues of phosphorus should be completely burned in the fume hood before being deposited in the waste jar.

- Each science teacher should be prepared to act deliberately and intelligently in the event of a classroom fire.

- All laws and regulations regarding animal use in school science instruction should be adhered to.

- Approved eye protection devices should be used by all persons performing science activities involving hazards to the eyes. All persons in dangerous proximity must be likewise equipped. Laboratory aprons and rubber or plastic gloves should be available and should be worn whenever hazards exist which could damage clothing, injure someone, or irritate skin.

- The safety of students while participating in field experiences should be considered integral parts of the instructional activities.

- Science teachers must be familiar with state, local, and district regulations on the use of equipment and materials which produce X-radiation; microwaves; and alpha, beta, and gamma radiation.

4. *Chemical Health Hazards*

Chemical substances can enter the body and, consequently, the bloodstream, in three ways: ingestion, absorption, or inhalation.

Examples of some of the classes of chemical substances and their effects:

- *ACIDS*: Acetic, chromic, hydrochloric, nitric, sulfuric, phenol (carbolic). Severe burns, tissue damage.

- *ALCOHOLS*: Irritants; methanol induces blindness via ingestion or prolonged inhalation; poisons.

- *ALDEHYDES AND KETONES:* Irritants and narcotic effects via inhalation, absorption, or ingestion.

- *ALKALIES:* Sodium and potassium hydroxides, ammonium hydroxide. Severe tissue burns, bronchial spasm.

- *ASPHYXIANTS:* Carbon monoxide, carbon dioxide, cyanide, cyanogen compounds. Reduce oxygen-carrying capacity of the blood, stop oxidation in tissues via enzyme destruction. Displace atmospheric oxygen.

- *CARBON MONOXIDE:* Toxic or deadly from prolonged exposure. Renders hemoglobin of red blood cells ineffective for oxygen transport.

- *COMPOUNDS OF SULFUR, PHOSPHORUS, NITROGEN:* Corrosive to the skin, destructive to respiratory tissues.

- *CYANIDES*: Toxic effects via absorption, inhalation, or ingestion.

- *ESTERS*: Tissue poisoning and irritation.

- *ETHERS*: Powerful narcotic effect via inhalation. See Section III-C-8 on page 68.

- *HALOGENS*: Corrosive, highly irritating to tissues.

- *HYDROCARBONS*: Irritation, tissue destruction via inhalation. *Prolonged exposure is very dangerous!* Chlorinated varieties form toxic phosgene gas when burned.

- *IRRITANTS:* Ammonia, phosphoric halides, hydrogen chloride, chlorine, bromine, hydrogen sulfide. Very damaging to respiratory tissues.

- *MERCURY:* Tissue poisoning via handling or inhalation of vapors. Toxic effects are compounded with prolonged exposure.

- *METAL FUMES:* Mercury, zinc. Tissue poison, causes nausea, fever, even death. *Always use a fume hood!*

5. *Establishing Safer Chemical Storage Areas (Step by Step)*

Recent state legislation (see Section I-E and Appendix I-E-1) as well as common sense require (1) that each school site have a trained member of its professional staff designated responsible for the review, update, and carrying out of the school's adopted procedures for laboratory safety; (2) that chemical storage areas be carefully examined for safety; (3) that especially hazardous chemicals, chemicals whose shelf-life has been exceeded, and chemicals no longer being used, be appropriately disposed of; (4) that an annual inventory be made of all hazardous materials and submitted to the appropriate local administering agency; and (5) that a Materials Safety Data Sheet (MSDS) received in the normal course of business be on file and accessible to employees (General Industry Safety Orders, Title 8, Section 5194).

All of these requirements point to establishing as safe a chemicals storage area as is possible and a plan that will ensure its continued maintenance in a safe manner.

Start as soon as possible. Carefully plan each step. Do not panic. The present condition may have existed for some time and will not likely deteriorate significantly as you assess your situation and examine your options. The result of your planning and its implementation should be a chemical storage area that has the following characteristics:

- The area is clean and orderly.
- A telephone is readily available.
- A current list of emergency phone numbers is posted.
- Emergency procedures are up-to-date and posted.
- An appropriate first-aid kit is available.
- An appropriate spill kit is available.
- Safety equipment and supplies (goggles, aprons, face shield, fire blanket, fire extinguisher, eyewash, spill pillow, and, if appropriate, deluge shower, safety shields, fume hood) are available and functional.

- There are no chemicals in storage that have been designated as unsafe for school laboratory use.
- Only chemicals that are used are stored (chemicals not needed have been disposed).
- Chemicals on hand will be consumed essentially within the next year.

- Chemicals are arranged for storage in compatible groups.
- Chemicals are properly labeled and stored in appropriate containers.
- A Material Safety Data Sheet (MSDS) is on file for each chemical that is received in the normal course of the school year. High school labs are partially exempt from having to get an MSDS for every chemical as long as they are under supervision of a "technically qualified individual" who both informs and trains the employees. This, however, is typically not the case at most school sites.
- There is a continuous up-to-date inventory of all chemicals, including quantity, location, date of purchase, shelf-life, and projected disposal date.
- No chemicals are stored above eye level.
- No chemicals are stored on the floor.
- Shelves or cabinets are secured firmly to the walls.
- Earthquake lips/barriers are in place on storage shelves.
- Storage cabinets for corrosive chemicals (separate for acids and for bases) are on site and are appropriately used.
- A storage cabinet for flammables is on site and is appropriately used.
- Poisons are secured.
- The storage area temperature never exceeds 25 degrees Celsius (75°F).
- The storeroom door is self-closing and is locked.
- There is adequate ventilation (a fume hood, if needed), isolated from the rest of the building. Room air is changed at least four times per hour.
- Compressed gas cylinders are secured upright to the wall, with caps in place. Flammable gases are separated from oxidizing gases by a one-hour fire wall or at least 25 feet (7.5 m).
- There are one or more nonreactive waste receptacles made of plastic or crockery.

Following is a suggested step-by-step procedure, assuming you have not inventoried and purged your chemicals storage area of dangerous and unnecessary chemicals in recent years or you are starting with a chemicals storage area that is unfamiliar to you. Hopefully, you have already accomplished much of this seven-step procedure:

Step 1--Identifying and Assigning Responsibility for Laboratory Safety

Education Code Section 49341 (see Appendix I-E-1) urges that each "school offering laboratory work have a trained member of the professional staff who is designated as the building laboratory consultant and who is responsible for the review, updating, and carrying out of the school's adopted procedures for laboratory safety."

The site administrator is responsible for making such an assignment and should carefully seek the person who has the greatest knowledge and experience in laboratory safety. Special consideration should be given to identifying a person with knowledge regarding chemical processes and hazardous chemicals.

Step 2--Explosives--Inventory and Removal

It is prudent to identify and dispose of any explosives that may be present to eliminate the most acutely dangerous materials and render it possible to proceed with subsequent steps in relative safety.

NOTE: DURING YOUR INITIAL INVENTORY, IF ANY OF THE FOLLOWING CHEMICALS ARE FOUND IN THE AREA, THE CONTAINERS SHOULD

NOT BE TOUCHED OR MOVED BY OTHER THAN TRAINED COUNTY SHERIFF OR POLICE BOMB SQUADS, OR OTHER QUALIFIED OFFICIALS. If any are present, call the appropriate district staff person or the local fire/sheriff's department.

CAUTION: This is not a comprehensive list of all possible explosive chemicals. Rather, it is a list of those that have, in the past, been recommended for use by various laboratory manuals and curriculum guides and, thus, are most likely to be present. Be alert for other explosives as you search for these. For disposal, consult Code of Federal Regualtions (CFR), Title 49, for the specific hazard class for each of the explosives listed below.

Explosive Chemicals

Substance	*Special Note*
Benzoyl Peroxide	May be exploded by heat, shock, or friction.
Carbon Disulfide	The flashpoint (-30°C) is well below room temperature, and small amounts of the vapor in air can be explosive.
Diisopropyl Ether	Becomes dangerous upon aging. If its age is unknown or if it has been in storage more than 12 months, it should be assumed that explosive peroxides have formed. If stored for less than 12 months, it can be disposed of by placing it in the fume hood, removing the cap, and allowing the liquid to evaporate.
Ethyl Ether/Diethyl Ether	Same as diisopropyl ether.
Nitrogen Triiodide	When it is dry, it will explode on being touched, vibrated, or heated slightly; even a puff of air will cause an explosion. May be stored in wet ether.
Perchloric Acid	Although the 70 percent perchloric acid/water mixture is not explosive by itself, the use of perchloric acid often leads to the formation of perchlorates which are very explosive. Perchloric acid may be set aside in a safe storage area until commercial disposal is arranged.
Picric Acid	Picric acid should always contain 10 to 20 percent water, and bottles should be disposed of after two years. Dry picric acid is explosive and can be detonated by shock or heat. Bouin's solution contains picric acid.
Potassium Metal	Becomes dangerous with age. Forms explosive peroxides if not stored under kerosene.
Sodium Azide	Very unstable and explosive. Keep away from heavy metals.

Once the explosives have been removed, it is appropriate to make preparation for the storage and transportation of hazardous materials. Some of the listed steps to follow can and should be done simultaneously.

Step 3--Chemicals Inventory

(A) *Purpose of Inventory*

The inventory:

- Can be used to meet the requirements of Health and Safety Code, Chapter 6.95, that an annual inventory be submitted to an administering agency (probably the County Department of Health Services). In many instances, the local fire department is also requesting such an inventory.

- Will apprise you of any extremely hazardous chemicals (acutely toxic, carcinogenic, mutagenic, etc.) that should be disposed of immediately and which require special permits issued by regional Toxic Substances Control Division. (See Appendix III-C-5a and b.)

- Will allow you to assess which chemicals are not used and should be disposed.

- Should provide a cursory check of whether the chemicals have deteriorated and are no longer usable (most chemicals are affected very little by age; however, some oxidize, others either collect or lose moisture, and still others become more hazardous). Loose or rusted caps may provide a basis for a closer look.

- Will provide an opportunity to relabel when labels are becoming obscure and to identify any whose labels are missing. All hazardous chemical wastes must be identified before disposal. A simple test at this time may provide the identity and, very importantly, will enable you to determine the hazard classes (and quantities of each) that you will need to ensure their safe storage.

Although all of the five preceding purposes are important, it is best to first complete the inventory; then attend to the clean-up, disposal, and reshelving in compatible groups.

(B) *Preparing for the Inventory*

In preparing, you should:

- Use at least two persons (no students) to perform the inventory for safety purposes.
- Allow sufficient uninterrupted time to complete the task.
- Be clothed properly (including goggles, apron, gloves) for the task.
- Have safety items (e.g., fire extinguisher, eyewash, spill kit, fume hood, half-mask respirator) available.
- Have flashlight and ladder available if necessary.
- Be sure the room is properly ventilated.
- Have a plastic broom, plastic dust pan, and plastic receptacle available for cleanup.
- Be prepared to handle unknown substances if they are encountered.
- Have alternate containers (bottles, cans, baggies, etc.) available in the event a broken container is encountered.
- Have replacement caps available.
- Use a method to record the inventory that will allow you to perpetually maintain the inventory.

- Notify school and fire authorities and maintenance personnel of the inventory undertaking.

- Plan how you will record the chemicals on a substance-by-substance basis.

  Suggestions for recording:

  (a) Use a small pocket tape recorder and read into it the chemical name, the concentration or purity, the type of container, the size of the container, and the approximate amount of chemical in the container (e.g., "Ferric Oxide, Practical, in a 500 g. plastic container, about one-third full"). If you expect a clerk or someone not familiar with chemicals to transcribe the list, you might want to spell the name of each substance.

  (b) Use Section 7 of the Council of State Science Supervisors (CSSS)-prepared publication *School Science Laboratories--A Guide to Some Hazardous Substances,* published by the U.S. Consumer Product Safety Commission, Washington, DC 20207. The publication is available for sale by the U.S. Government Printing Office, Washington, DC 20402. Section 7 of the publication has a list of chemicals most commonly used in schools, related hazards, and a space to record the amount.

  (c) Use a computer software chemical inventory system that contains features such as: printouts for all chemicals used in the laboratory with their related hazard class, the location of the chemical in the lab, the minimum desirable amount to be maintained, and the amount available at the site.

  (d) Start alphabetically, write the name, type of container, and quantity of each chemical in storage, and leave spaces to add hazard class, future storage, disposal information, etc. For example:

CHEMICAL INVENTORY

School				Room		Date
Inventory prepared by						
Chemical name	Concentration purity	Type of container	Quantity	Hazard class	Storage location	Shelf life
Acacia		Glass	.8 kg			
Acetic Acid	1.0 N	Glass	.5 l			

Step 4--Collection of Laboratory Residues and Wastes

(A) *Solids*

- Solid residues should be collected in stone crocks or plastic containers, not in a waste basket.

- A separate container should be provided for any flammable solid waste substance.

- Solid residues should not be put in sinks or toilets. Plumbing problems can be avoided by providing a screen or strainer for the drain in each sink.

(B) *Liquids*

- Flammable liquids should be poured into a safety can. Never flush flammable liquids into the plumbing system. Dangerous explosions could result from an accumulation of vapors!

Step 5--Preparing for the Temporary Storage and Eventual Transportation of Hazardous Wastes

It can be assumed that any high school has chemicals not only in the science department but in the art department, industrial arts department, and custodial office that are included on *The Director's List of Hazardous Substances*. Your site therefore generates hazardous wastes and must be prepared to store and dispose of those wastes appropriately.

To determine the kind and quantity of chemicals (waste) that may legally be treated and flushed down sink drains, school officials should consult with their local county health department and/or regional water quality control board. (If the school site is serviced by on-site sewage disposal fields, there may be severe limitations on what may be disposed down the drain. Check with the local Department of Health Services for advice.)

In any case, it will probably be necessary to store some hazardous substances temporarily on site and have them disposed of by a commercial industrial waste disposer.

These processes will likely be coordinated and enforced by your county Department of Health Services, which should be contacted for assistance, advice, and specific local procedures.

(A) *Storage of Hazardous Wastes*

Waste storage practices are designed to minimize the seriousness of a hazardous materials accident should one occur. Since most schools do not generate more than 100 kg (220 lbs.) of hazardous waste or 1 kg (2.2 lbs.) of extremely hazardous wastes during any calendar month, they need not be concerned about the 90-day storage limitation for hazardous wastes until they have accumulated the aforementioned quantities (California Health and Safety Code Section 25123.3b), at which point the hazardous waste material should not be stored on the school site for a period in excess of 90 days without a special state permit.

Hazardous wastes must:

- Be stored in nonleaking containers (storage drums) in good condition with close-fitting lids and must be kept closed when wastes are not being added or removed. (Contact the appropriate district official or consult the yellow pages of the telephone directory for sources of containers.)

- Be accurately labeled with waterproof labels. Labels must specify the words "Hazardous Waste," the composition and physical state of the waste, the hazardous properties of the waste (e.g., flammable, reactive, etc.), and the name and address of the generator.

- On each container include the date on which the period of accumulation began.

- Be handled in containers and in a way that minimizes the possibility of spills and escape of wastes into the environment. For example, waste chemicals placed in storage drums should remain in their shelf container--the chemicals themselves are not commingled.

- Be regularly inspected for deteriorating or leaking containers.

- If ignitable or reactive, be stored no less than 15 meters (50 ft.) from property lines.

(B) *Transportation of Hazardous Materials or Wastes*

NOTE: The Health and Safety Code (Chapter 6.5, Section 25163.c) states that:

A person hauling hazardous wastes to a permitted hazardous waste facility in quantities not exceeding five gallons or 50 pounds does not need to be registered with the State Department of Health Services as a hazardous waste hauler upon meeting all of the following conditions:

(1) The hazardous wastes are transported in closed containers and packed in a manner that prevents the containers from tipping, spilling, or breaking during the transporting.

(2) Different hazardous waste materials are not mixed within a container during the transporting.

(3) If the hazardous waste IS extremely hazardous waste, the extremely hazardous waste was not generated in the course of any business, and is not more than 2.2 pounds.

(4) The person transporting the hazardous waste is the producer of that hazardous waste, and the person produces no more than 100 kilograms of hazardous waste in any month.

While passenger vehicles generally are exempt from requirements of posting placards and labeling containers, trucks are *not* exempt and must comply with Department of Transportation's regulations. In general, anyone transporting hazardous materials should place them as far away from themselves as possible. Care should be taken to separate the chemicals according to their compatibility. Absorbents add an extra dimension of safety in the case of accidental spills.

(1) *Uniform Hazardous Waste Manifest*

Hazardous wastes to be transported must be accompanied by a Uniform Hazardous Waste Manifest form. (See Appendix III-C-5d for a sample manifest.) Each generator of hazardous wastes is responsible and liable for the wastes produced. Accurate completion of manifest forms and assurance that the notice is received when wastes have been delivered to the licensed hazardous waste facility permitted to receive that waste are the responsibilities of the hazardous waste generator.

All records of hazardous waste transported off site must be kept for at

least three years at the location where the waste was generated.

To obtain and complete a hazardous waste manifest, take the following steps:

(a) Obtain manifest forms by completing and mailing a Manifest Reorder Request form. (See sample in Appendix III-C-5c.)

(b) Obtain an Environmental Protection Agency Identification Number (EPA ID number). This number is needed on the manifest form. If you do not have an EPA ID number, you can get one by calling DOHS at (916) 324-1781.

(c) Fill in the top part of the manifest form completely and accurately. Directions for filling out the manifest form are listed on the back of the form. (See Appendix III-C-5d for a sample manifest.)

(d) Generator and transporter must sign manifest.

(e) The generator must keep a designated copy of the manifest and mail the appropriate copy to the California Department of Health Services (DOHS) as indicated at the bottom of the page. The remaining four copies of the manifest are to be given to the transporter.

(f) The licensed treatment, storage, or disposal facility (TSDF) will mail one signed copy back to the generator when the waste is received from the transporter. This copy must be kept for at least three years. If the copy from the TSDF is not received within 35 days, you should contact the transporter and/or operator of the TSDF to determine the status of the hazardous waste and also be sure to notify your regional DOHS, Toxic Substances Control Division (see Appendix III-C-5a).

(2) *Use of a Registered Hazardous Waste Hauler*

Hazardous wastes exceeding 50 pounds (22.5 kg) or 5 gallons (19 l) must be transported only by registered hazardous waste haulers to a state-permitted treatment, storage, or disposal facility. These haulers are registered by the State Department of Health Services. Hazardous wastes must be packed and labeled for transport in accordance with applicable Department of Transportation regulations.

(C) *Hazardous Waste Treatment and Disposal Practices*

Hazardous wastes may not be disposed of in the regular trash or on the surface of the ground. In addition, they may not be dumped in the sewer system (sink or toilet) unless you have an industrial waste discharge permit from your sewer agency.

If you wish to dispose of, treat, or recycle your hazardous waste to render it less hazardous or nonhazardous at your business location, you must obtain a Hazardous Waste Facility permit from the California Regional Office of the State Department of Health Services.

(D) *Biennial Reports*

On March 1 of each even-numbered year, your sites will be required to submit a report to the State Department of Health Services on wastes generated over the previous two-year period. Careful recordkeeping of all the school site manifests and receipts will be helpful in completing the appropriate forms.

Once the equipment and details are in place for waste storage and transportation, a

complete chemicals inventory should be made.

NOTE: You will receive a package from the DOHS called "Notification of Hazardous Waste Activity." If you need assistance in completing this package, call (916) 324-1781.

Step 6--Disposal

(A) *Preparation for Disposal*

In preparing wastes for disposal, you should:

- Use at least two persons (no students) to perform the procedures for safety.
- Allow sufficient uninterrupted time to complete the task.
- Be clothed properly (including goggles, apron, gloves) for the task.
- Have safety items (e.g., fire extinguisher, eyewash, spill kit, fume hood) available.
- Have flashlight and ladder available if necessary.
- Be sure that the room is properly ventilated.
- Have a plastic broom, plastic dustpan, and plastic receptacle available for cleanup.
- Prepare to handle unknown substances if they are encountered.
- Have alternate containers (bottles, cans, Baggies, etc.) available in the event a broken container is encountered.
- Have replacement caps available.
- Notify school authorities and maintenance personnel of the reshelving undertaken.
- Adapt plastic water bottles for solid residue disposal by cutting off the top and punching small drain holes in the bottom. Place the container in the sink for the disposal of solids. Only small amounts of nonregulated, nonflammable, water-miscible liquids may go down the drain. Check with your local Public Works Department or sanitation district (Water Quality Control Division) for specified limitations on disposable items.
- Dispose of small quantities of nonregulated, nonflammable, water-miscible liquid residues by pouring down the sink drain, using large amounts of water to dilute and flush the material through the plumbing system. Do not pour acids into a porcelain-lined sink. If corrosive, caustic, poisonous, or other controlled liquids need to be discarded, consult with the appropriate district staff member.
- Discard nonflammable solid wastes and broken glassware in a container separate from the trash container. Either of these types of waste substances can present a serious hazard to custodial employees during collection and disposal. Broken glassware should be wrapped in heavy paper, taped, and properly labeled: DANGER. BROKEN GLASS.

- Arrange for emergency communications in the event of a serious problem like a spill or a fire.
- Have space available to place the materials temporarily.
- Do as much preliminary housekeeping as possible to avoid physical obstacles that could lead to accidents.
- Eliminate all sources of ignition.
- If reshelving, identify and label the shelf/cabinet spaces for each category.
- If you plan to label each item by its hazard class, have the right information and labels to do the job.
- Plan how you will accommodate (or dispose of) the many bottles of solutions prepared and stored over recent years.

(B) *Extremely Hazardous Chemicals for Immediate Disposal*

The most seriously potential explosives were, presumably, disposed of in Step 2. There are additional chemicals whose potential hazards outweigh any benefit they can provide to the instructional program. It is recommended that all of the chemicals listed on the following page not be stored in schools and, if present, be properly disposed of. (The hazard class is included for disposal purposes.) Moreover, all schools that have carcinogenic chemicals (whether stored in the past or present) should be registered with Cal-OSHA. (See Appendix III-C-5e.)

To dispose of an "extremely hazardous waste," you will need to apply for a special permit which will be issued from one of the four regional Toxic Substances Control Division offices. You can find the address and phone number of the office closest to you by referring to Appendix III-C-5a. Also provided in Appendix III-C-5b is the application form to obtain the Extremely Hazardous Waste Permit.

(C) *Excess and Deteriorated Chemicals*

Once the extremely hazardous chemicals have been disposed of, an assessment must be made regarding which portion of the remaining inventory will be used during the next year (or, at the most, two years). The remainder should be appropriately disposed of. The process of determining the chemicals to keep should involve the entire staff that draws from the storage area for the instructional program. Once the decision is made regarding what to keep, the remainder can be disposed of by a commercial disposal service set up in Step 5.

Step 7--Storage Patterns

A number of safe storage patterns for hazardous chemicals have been developed and used in schools, colleges, and universities. The chemicals are sometimes arranged alphabetically and often by compatibility (or incompatibility) of the chemicals. While some patterns are better than others, none seems to be completely acceptable without making special provisions for certain chemicals that must be isolated for safety. In any case, the commonly used alphabetical shelving pattern must be abandoned in favor of one, for example, that separates the oxidizers from metals and that separates the flammables, the corrosives, and the poisons.

EXTREMELY HAZARDOUS CHEMICALS FOR IMMEDIATE DISPOSAL

(Authorized by AB 3820 (Papan), 1984, Chapter 1107)

Chemical name	Hazard	Hazard class	CAS number*
2-Acetylaminofluorine	Regulated human carcinogen	Poison B	53963
4-Aminodiphenyl	Regulated human carcinogen	Poison B	92671
Aniline	Acute toxin	Poison B	142-04-1
Arsenic Powder	Poison	Poison B	7440-28-2
Arsenic Compound (any)	Poison	Poison B	
Asbestos	Regulated human carcinogen	ORM-E**	1332-21-4
Benzene	Flammable, acute toxin, suspected carcinogen	Flammable	71-43-2
Benzidine (and salts)	Poison Regulated human carcinogen	Poison B	92-87-5
Cadmium Powder	Poison	ORM-E	7440-43-9
Cadmium Salts	Poison	ORM-E	
Carbon Tetrachloride	Acute poison narcotic	ORM-A	56-23-5
Chloroform	Suspected carcinogen Narcotic	ORM-A	67-66-3
Chromium (VI) Oxide	Suspected carcinogen	Oxidizer	1333-82-0
3,3-Dichlorobenzidene (and salts)	Human carcinogen	Poison B	91941
Dimethyl Amine	Acute toxin	Flammable	62759
4-Dimethylaminoazobenzene	Regulated human carcinogen	Poison B	60117
Ethylene Dichloride	Suspected human carcinogen	Flammable	569573
Ethyleneimine	Regulated human carcinogen, Poison, flammable	Flammable	151564
Ethylene Oxide	Suspected human carcinogen, acute toxin	Flammable	75-21-8
Hydrazine (anhydrous)	Flammable, acute toxin, suspected human carcinogen	Flammable	302012
Hydrofluoric Acid	Corrosive, toxic	Corrosive	7664-39-3
Lead Arsenate	High toxicity	Poison B	7784-40-9
Methylchloromethyl ether	Regulated human carcinogen	Flammable	170302
4-4-Methylene bis (2-chloroanaline)	Human carcinogen	Poison B	
Methylene Chloride	Suspected carcinogen, narcotic, acute toxin	ORM-A	75-09-2
Alpha-Naphthylamine	Regulated human carcinogen	Poison B	134327
Beta-Naphthylamine	Regulated human carcinogen	Poison B	91598
Nickel Powder	Acute toxin	Metals	7440-02-0
4-Nitrobiphenyl	Regulated human carcinogen	Poison B	92933
Beta-Propiolactone	Regulated human carcinogen		57578
Sodium Arsenate	Suspected carcinogen, acute toxin	Poison B	7631-89-2
Sodium Arsenite	Suspected carcinogen, acute toxin, deadly poison	Poison B	7784-46-5
Vinyl Chloride	Regulated human carcinogen	Flammable	75-01-4

*CAS = Chemical Abstracts Service
Title 8 of the *General Industry and California Administrative Codes. A Subfile NIOSH Toxic Substances List.* U.S. Department of Health, Education, and Welfare, Rockville, MD, June, 1975.
**ORM = Other Regulated Material. See Appendix III-C-7 for further explanation.

One popular system that works fairly well has been developed by Flinn Scientific, Inc. It has been further explained and recommended for use by the Council of State Science Supervisors in the publication *School Science Laboratories, A Guide to Some Hazardous Substances* (see References) and by others.

The essential elements of the Flinn system are used in this publication, with special consideration being given to separating and isolating chemicals and preventing their commingling in the event of a serious disaster such as a major earthquake or fire. This system also considers the hazard classes as established by the *Code of Federal Regulations 49* (Transportation). All storage shelves and cupboards should be fixed rigidly to the walls and be equipped with restraining lips, wires, or other barriers.

Chemicals within or near the main chemicals storage area should be selected on the basis of described needs (see diagram on page 40). The storage locations may be lockable cupboards, under-counter cabinets, or especially constructed (or purchased) cabinets as in the case of cabinets for acids, bases, and flammables. Each cabinet chosen should be clearly and permanently (or at least semipermanently) marked for its designated storage purpose. As much as possible, keep the chemicals in any special storage containers that are used in storing and shipping by the supplier.

Chemicals should be stored only in approved, locked cabinets within designated science storage rooms. Such storage rooms must be well ventilated and dry and must have adequate protection from direct sunlight. Lighting should be adequate. All cabinets should be locked when not in use, and the storage room should be kept locked. The instructor should be the only person with free access to the storage room. No student should be permitted in the storage room unless accompanied and supervised by the instructor. The following are specific recommendations for the safe storage of chemicals:

- Chemical substances must be stored in an orderly manner. All substances must be properly labeled, and an efficient retrieval scheme must be available to locate them. Alphabetical order is not appropriate except within compatible groups. Instead, refer to the recommended storage compatibility categories on page 39.

- Properly labeled safety containers must be used to store liquids which are highly volatile, potentially explosive, and/or flammable. Local fire departments should be consulted regarding minimum quantities for which safety containers are required.

- Flammable liquids should never be stored in open or ordinary metal cabinets. Ordinary metal cabinets provide no insulation from heat and will produce more shrapnel should an explosion occur. Approved, flammable liquid cabinets should be constructed of dense one-inch plywood. (See blueprint on page 143, Appendix III-C-2b.) The cabinets should be painted with intumescent fire-resistant paint; be provided with a self-closing door; have a positive latch and locks; and be clearly marked in large, contrasting letters, FLAMMABLE LIQUID STORAGE. KEEP FIRE AWAY!

- Adequate spacing between containers ensures proper air circulation and safe retrieval of chemicals. Therefore, do not over order.

- Extremely hazardous, unlabeled, or unidentifiable chemicals must not be kept in schools. Follow recommended procedures for the disposal of dangerous or unwanted or outdated chemicals.

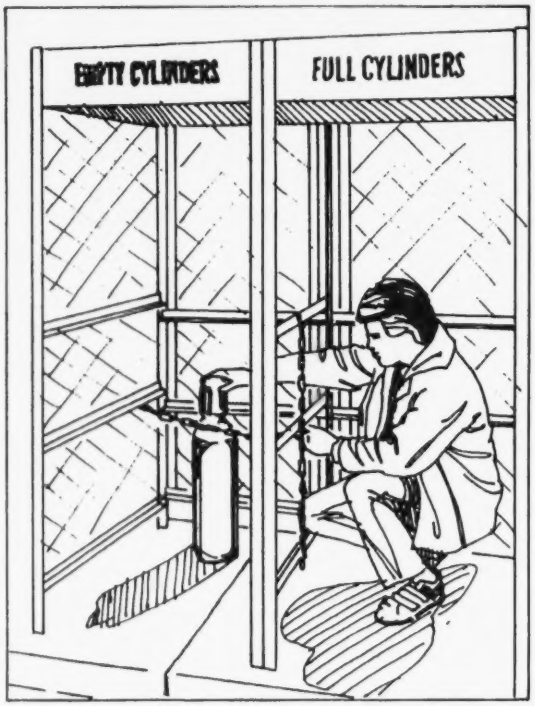
- Periodic ON-SITE inspections of chemical storage cabinets must be conducted. (See Appendix III-A-2, page 131, Safety Checklist for Science Instruction, Preparation, and Storage Areas.)

- An updated inventory list must be maintained for all chemical substances.

- Bottles containing acids or volatile organic liquids should be kept away from heating pipes or direct sunlight to avoid pressure buildup within the storage vessel.

- Bottled gas cylinders should be secured to a wall or counter to prevent upsetting. Rupture or unintentional opening of the release valve may cause serious personal injury and destruction of laboratory facilities, especially if the cylinder is not secured and becomes a projectile.

- Larger gas cylinders must be kept in the cart provided for their transport. Valves should be in perfect working order. When not in use, each cylinder must be secured against movement; that is, each must be held by a sturdy chain or strap connected to ring bolts that will not pull free. The cylinders must be located within an approved storage area. Move large gas cylinders only when regulator valves have been removed and safety covers have been installed.



A relatively safe, functional, practical pattern for chemical storage has separate storage provisions as indicated in the chart and diagram that appear on the next two pages.

6. *Labeling of Chemical Reagents*

Chemical reagent bottles or containers should have labels which state the following information:

- Generic name of the chemical and its chemical formula.

- Degree of hazard as designated by the correct signal word:

  - DANGER
  - WARNING
  - CAUTION

- Type of hazard(s) such as:

  - POISON
  - CAUSES BURNS
  - FLAMMABLE
  - HARMFUL VAPORS
  - EXPLOSIVE
  - TOXIC
  - CORROSIVE

CHEMICAL STORAGE COMPATIBILITY CATEGORIES

1. Metals. All metals, except mercury (see item No. 8 below). Phosphorus (red only; white or yellow phosphorus not recommended for school usage) should also be stored here. LOCATION: Separate from oxidizers (including ammonium nitrate), halogens, organic compounds, and moisture.

2. Oxidizers, *except* Ammonium Nitrate. Including nitrates, nitrites, permanganates, chromates, dichromates, chlorates, perchlorates, peroxides, and hydrogen peroxide 30 percent or greater. LOCATION: Separate from metals, acids, organic materials, ammonium nitrate. Preferably isolate from flammable liquids storage cabinet by a minimum of eight meters (25 feet) or a one-hour fire wall.

3. Ammonium Nitrate. Store in isolation from all other chemicals, especially acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials.

4. Bases. Strong bases--Sodium Hydroxide, Potassium Hydroxide, and other regulated bases and Ammonium Hydroxide. Store in a dedicated corrosive chemicals storage cabinet with the inside constructed entirely of corrosion-resistant materials.

5. Acids--Inorganic (except Nitric Acid) and regulated organic acids. Store in a dedicated corrosive chemicals storage cabinet with the inside constructed entirely of corrosion-resistant materials.

   NOTE: Items 4 and 5 may be stored in the same storage cabinet if necessary; however, fumes from acids and bases combine to produce various salt crystals which coat the walls and the containers.)

6. Nitric Acid. Must be stored separately from Acetic Acid. Store either in isolated compartment in the acids cabinet or in special styrofoam containers available for that purpose from vendors of chemicals. Fuming nitric acid should never be used.

7. Flammables (and Formaldehyde). Store in a dedicated wood flammables storage cabinet with heat/flame retardant paint. Preferably, isolate from all oxidizers by a minimum of eight meters (25 feet) or a one-hour fire wall.

8. Poisons: Cyanides (no longer recommended for school programs), mercury and mercury compounds, nicotine, and other poisons. LOCATION: Use a lockable drawer remote from the acids storage cabinet.

9. Compressed Gases. Store chained/strapped to wall with caps on tight. LOCATION:
   a. Oxidizing gases remote from flammable liquids, metals, and flammable gases.
   b. Flammable gases remote from oxidizers and oxidizing gases by eight meters (25 feet) or a one-hour fire wall.

10. Low Hazard Chemicals. Store on open shelves with earthquake barriers. Includes many of the salts not otherwise specified (of course, *not* the nitrates), weak bases, oxides, carbonates, sulfides, dyes, indicators, stains, noncorrosive organic acids, amino acids, sugars, etc.

- Precautionary measures, such as instructions which describe how to avoid injury. Such statements could be:
  - KEEP AWAY FROM HEAT, SPARKS, OR OPEN FLAME.
  - AVOID CONTACT WITH EYES, SKIN, OR CLOTHING.
  - USE ONLY WITH ADEQUATE VENTILATION.
- Instructions for cases of ingestion, contact, or exposure.
- Below is an example that addresses each of the aforementioned precautions.

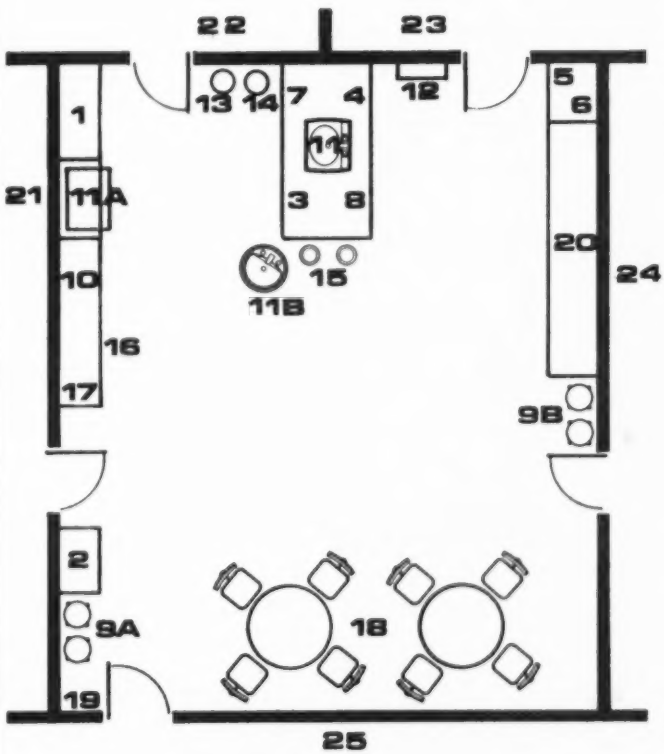
IN CASE OF CONTACT WITH EYES, FLUSH WITH WATER CONTINUOUSLY FOR 15 MINUTES AND GET MEDICAL ATTENTION IMMEDIATELY.

HCl
Hydrochloric Acid

Warnings:

- Causes burns.
- Avoid contact with skin and eyes. Avoid breathing vapor.
- In case of contact, immediately flush skin or eyes with large amounts of water for at least 15 minutes. For eyes, get immediate medical attention.

Preparation/Storage Area Diagram



1. Metals storage
2. Oxidizers storage
3. Ammonium nitrate storage
4. Bases cabinet } may be combined if necessary and contain item 6 if isolated
5. Acids cabinet
6. Isolated nitric acid storage
7. Flammables cabinet
8. Poisons drawer
9A. Compressed gases--nonflammable/oxidizing chained/strapped to a wall
9B. Compressed gases--flammable chained/strapped to a wall
10. Low hazard chemicals storage with earthquake lips; secured to walls
11. Sink/counter with hot/cold water, gas, electricity, eye wash, exhaust hood over, cabinet underneath
11A. Refrigerator
11B. Emergency shower
12. First-aid kit
13. ABC Fire extinguisher
14. Fire blanket
15. Plastic waste receptacles
16. Chemical spill kit
17. Chemical inventory system, including MSDS
18. Conference/prep area
19. Emergency evacuation procedure
20. Apparatus/glassware storage cabinets secured to walls with earthquake lips

21-24. Adjacent classroom laboratories

25. Hall or outside exit; all doors self-closing and lockable

- Proper labels can be obtained from most chemical or safety supply houses.

7. *Potentially Hazardous Chemicals*

This section, which includes a 24-page chart beginning on the next page, lists many of the chemicals that can be found in high school science labs. Chemicals of dubious value because of associated hazards are marked with a single asterisk. Chemicals with two asterisks are recommended for disposal. District staff are advised to make their own decisions about the acquisition and use of laboratory chemicals. If an especially hazardous chemical is deemed essential to the program, the corresponding responsibility to ensure safe storage and use must be assumed. When in doubt, school staff should contact district staff or other appropriate agencies.

For each chemical listed there is specific labeling information from OSHA, if necessary, and potential hazard and advice on first aid followed by a four-part code. An example of this code is as follows:

Acetone code (See Acetone on page 42): 7/2S/2/FLAMMABLE

$7^{a}/2S^{b}/2^{c}$/FLAMMABLE^{d}*

(Text continued on page 68)

* [a]Chemical Storage Compatibility Categories 1-10 (page 39).

[b]Suggested Type of Container
1. Glass or polyethylene bottle. W--store under water surrounded by sand in a large container; KM--store under kerosene or mineral oil surrounded by sand in a larger container.
2. Metal Can. S--Safety can for larger quantities.
3. Wax (or plastic) bottle in a container of kaolin or other absorbent.

(When possible, maintain the original container and packaging from the vendor for storage.)

[c]Shelf Life
1. Poor: Less than one year with special storage.
2. Fair to good: Up to three years, variant with temperature, humidity, etc.
3. Excellent/indefinite, essentially indefinite in time and invariant in terms of conditions.

[d]Hazard Class from *Code of Federal Regulations 49* (Transportation). Provides transportation class/compatibility for commercial disposal. Appendix III-C-7 provides an explanation for the terms used.

POTENTIALLY HAZARDOUS CHEMICALS FOUND IN LABORATORY SUPPLIES

Adapted from Precautions with Chemicals. Publication No. SC865. Los Angeles: Office of Secondary Education, Los Angeles Unified School District, 1984.

Name	Label	Hazard	First Aid
Acetic acid, Glacial	DANGER! Causes severe burns. Do not get liquid or vapor in eyes, on skin, or on clothing. Keep away from heat and flame. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes get medical attention. Glacial acetic acid freezes at 62 degrees F (16 degrees C). If frozen, thaw by carefully moving carboy to warm area. 5/1/3/CORROSIVE	Organic acid causes painful wounds when it comes in contact with skin. High vapor concentrations may produce allergic reactions.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
Acetone	DANGER! Extremely flammable. Keep away from heat, sparks, and open flame. Keep container closed. Use adequate ventilation. Avoid prolonged or repeated contact with skin. 7/2S/2/FLAMMABLE	Highly flammable liquid. An irritant to skin, throat, and lungs. Toxic by ingestion.	*External*--Remove victim to fresh air. Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
Aluminum Chloride, Anhydrous	5/1/3/CORROSIVE	Reacts violently with water to generate heat and hydrogen chloride gas fumes and hydrochloric acid, which are irritating and toxic. Causes burns to skin and eyes. Dust inhalation will irritate or burn membranes. Ingestion can cause severe burns.	*External*--Irrigate eyes/skin with water for 15 minutes. *Internal*--Do not give emetic. Seek immediate medical attention.
Aluminum Chloride, Crystal	10/1/3/CORROSIVE		*External*--Irrigate eyes with water for 15 minutes. *Internal*--Soluble forms may be corrosive; do not give emetic. Seek immediate medical attention.
Aluminum Metal	1/2/3/FLAMMABLE (powder)	Easily ignited. May explode. Can have hazardous reactions with metal oxides.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
Aluminum Sulfate	10/1/3/ORM-E	May react violently with water. Readily hydrolyzes to form sulfuric acid. Dust/vapor may be harmful if inhaled.	*External*--Irrigate exposed eyes and skin thoroughly for 15 minutes. *Internal*--Do not give emetic. Seek immediate medical attention
Ammonium Carbonate	10/1/3/ORM-A	Evolves irritating fumes when heated.	*External*--Irrigate exposed eyes with water for 15 minutes. Seek medical attention. *Inhalation*--Move to fresh air. Seek medical attention. *Internal*--Do not give emetic. Seek medical attention.
Ammonium Chloride	10/1/1/ORM-E	Moderately toxic by ingestion. Fire may produce irritating or poisonous gas.	*Internal*--Seek immediate medical attention.
*Ammonium Dichromate	WARNING! Flammable. Harmful dust. May cause rash or external ulcers. Keep away from heat, sparks, and open flame. Keep container closed. Avoid contact with skin and eyes. Avoid breathing dust or solution spray. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. Use fresh clothing daily. Take hot shower after work, using plenty of soap. 2/1/1/OXIDIZER	Primary irritant to skin, eyes, and lungs; strong oxidizer produces chromic oxide--a burning lung irritant which may produce skin ulcers and cause skin inflammation. Continued inhalation may cause damage to the respiratory tract. Suspected carcinogen.	*External*--Ammonium dichromate produces chromium trioxide on the skin. Wash thoroughly with water. Seek medical attention. *Internal*--Seek immediate medical attention. Avoid emetics. Maintain respiration. Causes ulceration of the nose, skin, and intestinal tract, toxic to the lungs.
Ammonium Hydroxide	WARNING! Liquid causes burns. Vapor extremely irritating. Avoid breathing vapor. Avoid contact with skin, eyes, and clothing. In case of contact, immediately flush skin with plenty of water at least 15 minutes; for eyes, get medical attention. 4/1/3/CORROSIVE	Caustic inorganic base; gas and vapor toxic; strong eye, lung, and skin irritant.	*External*--Irrigate eyes with water for 15 minutes. Wash with soap and water. In the event of spillage, neutralize with vinegar or dilute acetic acid. *Internal*--Do not use emetics. Remove to fresh air. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
Ammonium Nitrate	3/1/2/OXIDIZER	Will decompose above 160 degrees Celsius (320 degrees F.). It produces explosive gaseous substances, especially when confined in a closed container. Oxidizer.	If exposed to products of combustion, seek immediate medical attention. *External*--Irrigate eyes and skin for 15 minutes; for eyes, contact doctor. *Internal*--If conscious, induce vomiting; seek immediate medical attention.
Ammonium Persulfate	2/1/3/OXIDIZER	Strong oxidizer. Suspected carcinogen.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
**Aniline	DANGER! Hazardous liquid and vapor. Rapidly absorbed through skin. Do not get in eyes, on skin, or on clothing. Avoid breathing vapor. Use only with adequate ventilation. In case of contact, immediately remove all contaminated clothing, including shoes, and flush skin or eyes with plenty of water for at least 15 minutes; get medical attention. Wash clothing before reuse. Dispose of!--/1/POISON B	Suspected teratogen. Dangerous when inhaled, swallowed, or absorbed through skin contact. Flammable. May give off explosive vapors when heated. May cause headache and dizziness, which may later develop into cyanosis.	*External*--Wash off skin promptly. Flush eyes with water for 20 minutes. In case of spill, promptly discard materials used to wipe up spills. Scrub traces left on floors or tables with a strong soap solution. Bed rest may reverse headaches and dizziness. *Internal*--Seek immediate medical attention. May cause convulsion, respiratory arrest, shock.
Antimony	DANGER! Causes severe burns. Vapor hazardous. Do not get in eyes, on skin, or on clothing. Do not breathe vapor. Keep container closed. In case of contact, immediately remove all contaminated clothing and flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. 1/1/3/--	Highly toxic; a poison if swallowed, inhaled, or absorbed through the skin. Dust is eye irritant.	*External*--Wash eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Induce vomiting. Maintain respiration. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
**Arsenic/ Arsenic Trioxide	DANGER! Causes severe burns. Vapor extremely hazardous. Do not get in eyes, on skin, or clothing. Do not breathe vapor. Keep container closed. In case of contact, immediately remove all contaminated clothing, including shoes, and flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. Dispose of/1/2/POISON B	Causes dermatitis and lung and lymphatic complications when swallowed, inhaled, or absorbed through skin contact. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Induce vomiting. Seek immediate medical attention.
**Asbestos	 Dispose of/10/2/ORM-C	Known carcinogen	*Internal*--Inhalation of fibers may cause toxicity; chest x-ray may be indicated.
Barium (soluble compounds)	WARNING! May be fatal if swallowed. Avoid inhalation of dust. Avoid contact. 2/1/1/--	Extremely poisonous when inhaled, swallowed, or absorbed through skin contact.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Induce vomiting. Seek immediate medical attention.
Barium Chloride	WARNING! May be fatal if swallowed. Avoid inhalation of dust. 10/1/3/POISON B		(Same as soluble compounds)
Barium Hydroxide	 10/1/1/POISON B	Poisonous when swallowed. (Same as soluble compounds)	*Internal*--Induce vomiting. Seek medical attention
Barium Nitrate	WARNING! Contact with combustible material may cause fire. May be fatal if swallowed. Keep container closed and away from combustible material and heat. Avoid contact with skin and eyes. Keep away from feed or food products. 2/1/3/OXIDIZER	Toxic oxidizer.	*Internal*--Induce vomiting. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
**Barium Peroxide	Dispose of 2/1/1/OXIDIZER	Powerful oxidizer. Toxic and ignitable.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
**Benzene	DANGER! Extremely flammable. Vapor harmful--poison. Keep away from heat, sparks, and open flame. Keep container closed. Use only with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid prolonged or repeated contact with skin. Dispose of/--/2/FLAMMABLE	Acute irritation of mucous membranes, restlessness, convulsions from inhalation or ingestion; blood changes, including leukemia. Suspected carcinogen; may be absorbed though skin. Flammable.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
**Benzidine	WARNING! Hazardous solid and vapor. Rapidly absorbed through skin. Repeated absorption may result in bladder tumors. Avoid breathing dust or vapor. Avoid contact with skin and eyes. In case of contact, immediately wash skin with soap and plenty of water; flush eyes with plenty of water for at least 15 minutes and get medical attention. Wear fresh clothing daily. Take hot shower after work, using plenty of soap. Dispose of/--/--/POISON B	Known carcinogen. Solid and vapor rapidly absorbed through skin. Produces bladder tumors; liver, kidney, and bone marrow damage. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Give emetic. Seek immediate medical attention.
**Benzoyl Peroxide	Dispose of/--/1/ORGANIC PEROXIDE	May explode when heated. May also be exploded by shock or friction. Airway and eye irritant. May cause harmful effects to the skin. Dangerous chemical.	*Internal*--Support respiration. Inhalation can be FATAL. Seek immediate medical attention.
Bismuth and Alloys	1/1/3/FLAMMABLE SOLID	Flammable in powder form. Wear goggles to avoid injury to eyes.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water *Internal*--Maintain respiration. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
Boric Acid	5/1/3/CORROSIVE	Ingestion by young children can cause severe vomiting, diarrhea, shock, and death. Inhalation is toxic. Skin irritant.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
*Bromine (ampule)	DANGER! Causes severe burns. Vapor hazardous. Do not get in eyes, on skin, or on clothing. Do not breathe vapor. Wear goggles, neoprene rubber gloves, and rubber protective clothing when handling. In case of contact, immediately remove all contaminated clothing, including shoes, and flush skin with plenty of water for at least 15 minutes. Flush eyes for at least 30 minutes. Get medical attention in all cases. Wash clothing before reuse. If inhaled, remove patient to fresh air, keep warm and quiet until physician arrives. 10(ampule) or 2/1/3/CORROSIVE	Poisonous. Liquid causes severe skin burns. Exposure to high vapor concentrations could be deadly. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Ventilate area. Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
Butyl Alcohols: n-Butyl tert-Butyl	CAUTION! Avoid prolonged breathing of vapor. Use with adequate ventilation. Avoid prolonged or repeated contact with skin. 7/1 or 2S/2/FLAMMABLE	Flammable liquid. "tert" is a flammable solid when in crystalline state. Prolonged inhalation can be toxic. Eye irritant. Absorbed by skin.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
sec- Butyl Alcohol	Same Label as Butyl alcohol 7/1 or 2S/1/FLAMMABLE	Same as Butyl alcohol	Same as Butyl alcohol
**Cadmium	WARNING! Harmful dust. Avoid prolonged breathing of dust. Keep away from feed or food products. Do not take internally. Dispose of/--/3/POISON B	High concentration of fumes or dust extremely dangerous. Dust, vapor, solids, and liquids; harmful to eyes, lungs, and skin. Poisonous. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
*Calcium Carbide	(Tightly sealed) 7/1 or 2/2/FLAMMABLE SOLID (Tightly sealed)	Exposure to moisture produces explosive gas and corrosive solid. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
Calcium Chloride (anhydrous)	10/1/1/---	Acute ingestion may result in intestinal irritation and hemorrhage.	*External*--Wash with water. *Internal*--Seek immediate medical attention.
Calcium Chloride (dihydrate)	10/1/1/---	Irritant. Mucous membrane damage might occur.	*External*--Eyes should be flushed with water for 15 minutes. *Internal*--Maintain respiration. Seek immediate medical attention.
Calcium Hydroxide	Avoid inhalation and skin contact. 10/1/1/CORROSIVE BASE	Inorganic base (caustic). Skin irritant. Avoid dust inhalation.	*External*--Irrigate eyes with water. If calcium hydroxide contacts eyes, seek immediate medical attention. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
Calcium Hypochlorite	2/1/1/OXIDIZER	Poisonous, corrosive powder, harmful to eyes, lungs, and skin. Emits chlorine gas under certain conditions. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Seek immediate medical attention.
Calcium Metal	Avoid contact with water. Store in tightly closed container. Avoid contact with oxidizers. 1/1KM/2/FLAMMABLE	Contact with water, acids, alkali, hydroxides, or carbonates may cause detonation. Burns in air. Dust and fumes are highly toxic. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water for 15 minutes. If calcium contacts eyes, seek immediate medical attention. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
Calcium Nitrate	2/1/1/OXIDIZER	Strong oxidizer; potential fire risk with organic material. May explode if shocked or heated.	*Internal*--Induce vomiting and seek immediate medical attention.

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** Dispose of immediately!

Name	Label	Hazard	First Aid
Calcium Oxide (lime)	10/1 (polyethyline) Keep dry/1/CORROSIVE BASE	Strongly caustic. May cause severe irritation of skin and mucous membrane. Exposure to water or moisture evolves heat. Wear eye protection.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Seek immediate medical attention.
Camphor	7/1/3/COMBUSTIBLE	Poisonous on ingestion. If heated, flammable and explosive vapors evolve. Moderately toxic.	*Internal*--Induce vomiting. Seek immediate medical attention.
**Carbon Disulfide	DANGER! Extremely flammable. Vapor harmful. Highly volatile. Keep away from fire, sparks, or heated surfaces. Store in cool place and keep container closed. Use only with adequate ventilation. Avoid breathing vapor. Avoid contact with skin and eyes. Dispose of/2S/2/FLAMMABLE	Highly flammable liquid. Poisonous if swallowed. Affects heart, eyes, lungs, nervous and reproductive systems.	*External*--Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
**Carbon Tetrachloride	DANGER! Hazardous vapor and liquid. May be fatal if inhaled or swallowed. Use only with adequate ventilation. Do not breathe vapor. Avoid prolonged or repeated contact with skin. Do not take internally. Dispose of/--/3/ORM-A	Highly toxic if inhaled, swallowed, or absorbed through the skin. Known carcinogen.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
**Chloroform (trichloro-methane)	WARNING! Vapor harmful. Use only with adequate ventilation Avoid breathing vapor. Avoid prolonged or repeated contact with skin. Do not take internally. Dispose of/--2/ORM-A	Prolonged inhalation may be fatal. Primary irritant to skin, eyes, and lungs. Can cause liver or kidney tumors and central nervous system effects. Suspected carcinogen.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Chromates	2/1/3/ORM-E	Both solid and solution: primary irritant to eyes, skin, and respiratory system. Carcinogenic. Avoid physical contact. Practice strict hygiene in the use of these substances.	*External*--Irrigate eyes with water for 15 minutes. Call for immediate medical treatment of an ophthalmologist. Wash contaminated areas of body with abundant quantities of water. Seek immediate medical attention. *Internal*--If ingested, induce vomiting. Seek immediate medical attention. Maintain respiration. *Inhalation*--Move to fresh air. Seek medical attention.
*Chromic Acid (Chromium Trioxide)	DANGER! Contact with combustible material may cause fire. May cause burns or external ulcers. Keep container closed. Avoid contact with skin and eyes. Avoid breathing dust or mist from solutions. In case of contact, immediately flush skin for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. Use fresh clothing daily. Take hot shower after work, using plenty of soap. 2/1/1/OXIDIZER	Corrosive; strong oxidizing agent. Precautions should be taken to avoid skin contact or inhalation of the dust. This acid will ignite ethanol and similar liquids on contact. Suspected carcinogen.	*External*--Irrigate eyes with water for 15 minutes. Call for immediate medical treatment by an ophthalmologist. Wash contaminated areas of body with abundant quantities of water. Seek immediate medical attention. *Internal*--If ingested, induce vomiting. Seek immediate medical attention. Maintain respiration.
Copper Salts	10/1/--/--	Toxic by ingestion. Soluble salts are strong irritants to mucous membrane and skin.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Seek immediate medical attention. Maintain respiration.
Cupric Chloride	10/1 or 2/1/ORM-B	(See Copper Salts.)	
Cupric Nitrate	2/1 or 2/1/OXIDIZER	(See Copper Salts.)	
Cupric Oxide	10/1 or 2/3/POISON B	(See Copper Salts.)	

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Name	Label	Hazard	First Aid
Cupric Sulfate	10/1 or 2/2/ORM-E	(See Copper Salts.)	
Cyclohexane	DANGER! Extremely flammable. Keep away from heat, sparks, and open flame. Keep container closed. Use with adequate ventilation. Avoid prolonged breathing of vapor. 7/1 or 2S/3/FLAMMABLE	Flammable; vapor and liquid harmful to eyes, lungs, and skin.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Do not induce vomiting. Seek immediate medical attention.
*p-Dichlorobenzene (moth balls)	7/1/1/ORM-A	Flammable; vapor harmful to eyes, lungs, and skin. High concentration may cause liver injury. Suspected carcinogen.	*External*--Ventilate area. Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Seek immediate medical attention.
Diethyl Ether/ Ethyl Ether	DANGER! Extremely flammable. Highly volatile. Tends to form explosive peroxides, especially when anhydrous. Keep away from heat, sparks, and open flame. Keep container tightly closed Do not allow to evaporate to near dryness. Addition of water or appropriate reducing agents will lessen peroxide formation. 7/2S or PVC-coated bottles/1/FLAMMABLE	Flammable, light-sensitive. During storage most ethers are subject to the formation of ether peroxides, which make ether highly explosive. If stored more than 12 months, dispose of by calling bomb squad.	*External*--Ventilate area. Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Seek immediate medical attention.
Ethyl Alcohol	7/2 or 2S/3/FLAMMABLE	Poison. Vapor toxic. Fire hazard. Denaturant makes product more toxic.	*External*--Wash affected parts with copious quantities of water. *Internal*--Wash mouth. See a physician.
**Ethylene Dichloride (EDC)	WARNING! Flammable. Vapor harmful. Keep away from heat and open flame. Keep container closed. Use only with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid prolonged or repeated contact with skin. Do not take internally. Dispose of /--/2/FLAMMABLE	Flammable. Vapors are irritating to the respiratory tract. Suspected carcinogen, mutagen, and teratogen.	*External*--Ventilate area. *Internal*--Can cause narcosis. Maintain respiration. Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Ferric Chloride	10/1/1/ORM-B	Skin and tissue irritant; corrosive	*External*--Irrigate eyes/skin with water for 15 minutes. Seek medical attention. *Internal*--Give emetic, seek medical attention.
Ferric Nitrate	2/1/1/OXIDIZER	Strong oxidizer. Contact with organic material may cause fire. Skin and tissue irritant.	Wash thoroughly after handling.
Ferrous Sulfate	10/1/1/ORM-E	Toxic by ingestion	*Internal*--Give emetic unless solution is very acid. Seek immediate medical attention.
*Formaldehyde (Formalin)	WARNING! Causes irritation to skin, eyes, nose, and throat. Avoid prolonged or repeated contact. Avoid prolonged breathing of vapor. Use with adequate ventilation or with fume hood. 7/1/2/ORM-A	Vapor irritating to eyes and lungs. Flammable. Toxic compound. Known animal teratogen and carcinogen. Dangerous when inhaled, swallowed, or absorbed through skin contact. Use only diluted solutions.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Seek immediate medical attention.
Formic Acid	WARNING! Causes burns. Avoid contact with skin and eyes. Avoid breathing vapor. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 5/1/3/CORROSIVE	Toxic compound. Concentrated form is unstable and subject to explosion. Painful wounds on contact with skin.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
Hexane	7/1 or 2S/3/FLAMMABLE	Flammable. May be irritating to respiratory tract and narcotic in high concentrations.	*External*--Ventilate area. Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
**Hydrazine, Anhydrous	Dispose of/--/--/--/FLAMMABLE	Flammable. Extremely dangerous when inhaled, swallowed or absorbed through skin contact. Suspected carcinogen. Disposal requires an Extremely Hazardous Waste permit.	*External*--Irrigate eyes with water. Wash skin with soap Seek immediate medical attention. *Internal*--Seek immediate medical attention. Maintain respiration.

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Name	Label	Hazard	First Aid
Hydrochloric Acid	WARNING! Causes burns. Avoid contact with skin and eyes. Avoid breathing vapor. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 5/1/2/CORROSIVE	This chemical is dangerous when inhaled, swallowed, or absorbed through skin contact. Corrosive solution and fumes. *Warning*--causes burns. Disposal requires an Extremely Hazardous Waste Permit.	*External*--In case of contact immediately flush skin or eyes with large amounts of water for at least 15 minutes; for eyes, get medical attention immediately. *Internal*--If ingested, seek immediate medical attention.
**Hydrofluoric Acid	WARNING! Causes burns. Avoid contact with skin and eyes. Avoid breathing vapor. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Dispose of/3/2/CORROSIVE	Causes severe, immediate reaction with skin tissue and bones. Burns may not be painful or visible for several hours.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Seek immediate medical attention.
Hydrogen Peroxide (3%)	 10/1/1/OXIDIZER	Avoid contact with eyes. Do not heat this substance.	*External*--Rinse with water soon after contact.
Hydrogen Peroxide (30%)	CAUTION! Strong oxidant. Avoid contact with skin and eyes. Wear rubber gloves and goggles. Avoid contamination from any source, including metals, dust, etc. Such contamination may cause rapid decomposition, generation of large quantities of oxygen gas, and high pressures. Store in original closed container. Be sure that the container vent is working satisfactorily. Do not add any other product to this container. When empty, rinse thoroughly with clean water. 2/1 vented cap/1/OXIDIZER	Strong oxidant; avoid contact with combustible materials. High concentrations can cause burns to the eyes, lungs, and skin. Do not heat this substance. Store in original container.	*External*--Flush with water. Use burn ointment. Seek medical attention. Remove and wash contaminated clothing promptly and thoroughly.
Iodine	 2/1/2/POISON B	Inhalation of vapors or ingestion may be fatal. Vapor corrosive to eyes and respiratory tract. Solid stains the eyes and skin. Stain is poisonous.	*External*--Remove iodine stains by washing first with a sodium thiosulfate solution and then with water. *Internal*--Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Isobutyl Alcohol	7/1 or 2S/3/FLAMMABLE	Flammable. Mildly irritating to skin, eyes, and mucous membranes. Mildly toxic.	*External*--Rinse eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
Isopropyl Alcohol	7/1 or 2S/3/FLAMMABLE	Flammable. Toxic by ingestion and inhalation.	*External*--Eye irritant. Irrigate eyes with water. *Internal*--Seek medical attention.
Kerosene	7/1 or 2S/3/COMBUSTIBLE	Flammable. Irritating to skin. Can cause infection. High concentrations of vapors are toxic.	*External*--Wash skin with soap and water. *Internal*--Do not give emetics. Seek immediate medical attention.
Lead	1/2/3/ORM-B	Toxic; poison is cumulative. Dust very harmful to kidney, blood, and nervous system. Suspected teratogen.	*External*--Wash skin with water. Seek immediate medical attention.
Lead Acetate	WARNING! Harmful dust. Avoid breathing dust. Wear dust mask approved by U.S. Bureau of Mines for this purpose. Wash thoroughly before eating or smoking. Keep away from food or food products. 10/1/1/ORM-E	Known animal carcinogen. Eye, skin, and respiratory irritant. Reacts violently with bromates.	*Inhalation*--Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*--Induce vomiting. Seek immediate medical attention. *External*--Irrigate skin/eyes with water. Seek immediate medical attention.
Lead Carbonate	10/1/ 11/ORM-B	Toxic by inhalation and ingestion. Skin, eye, and respiratory irritant.	(Same as Lead Acetate)
Lead Chloride	10/1/3/ORM-B	Toxic by inhalation and ingestion.	(Same as Lead Acetate)
Lead Nitrate	2/1/3/OXIDIZER	Toxic by inhalation and ingestion. Serious fire risk in contact with organic material.	(Same as Lead Acetate)
Lead Oxide	(Same label as Lead Acetate) 10/1/3/ORM-C	Toxic by ingestion and inhalation.	(Same as Lead Acetate)

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Name	Label	Hazard	First Aid
Lead Peroxide (Dioxide)	2/1/3/OXIDIZER	Toxic by inhalation and ingestion. Dangerous fire risk in contact with organic material.	(Same as Lead Acetate)
Lead Sulfate	10/1/3/ORM-E	Toxic; serious skin irritant.	(Same as Lead Acetate)
Lead Sulfide	10/1/3/ORM-E	Toxic by ingestion and inhalation.	(Same as Lead Acetate)
Lithium	Dangerous water reactive; explosion risk. Use a class D fire extinguisher. 1/1KM/3/FLAMMABLE	Causes severe burns on contact with skin, eyes or lungs. Ignites spontaneously in moist air; highly flammable. Compounds toxic if swallowed; avoid inhalation of dust and skin contact. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Flush with water. Seek immediate medical attention.
Lithium Nitrate	2/1/3/(OXIDIZER)	Risk of explosion when shocked or heated. Strong oxidant.	*Internal*--Induce vomiting, unless patient is comatose or convulsing or has lost gag reflex.
Magnesium Chloride	10/1/1/---	Moderately toxic by ingestion. Dusts may be irritating. Overexposure causes nausea and vomiting.	*Internal*--Inducing vomiting and seek immediate medical attention.
Magnesium Metal (powder/ribbon)	1/2/3/FLAMMABLE	Dangerous in powder form because of fire potential. Magnesium burns are often severe and may be slow to heal. Disposal requires an Extremely Hazardous Waste Permit.	*External*--In case of burns, seek immediate medical attention.
Magnesium Nitrate	2/1/1/OXIDIZER	Strong oxidant. Fire and explosion risk in contact with organic material. Skin, eye, and respiratory tract irritant.	*External, Internal, Inhalation*--Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Magnesium Oxide	10/1/1/POISON B	Dust toxic by inhalation.	*External, Internal, Inhalation*--Seek immediate medical attention.
Magnesium Sulfate (Epsom salts)	10/1/1/CORROSIVE B	Irritates eyes and respiratory tract.	*External*--Flush eyes with water for 15 minutes. *Inhalation*--Move to fresh air, seek medical attention.
Manganese Dioxide	2/1/3/OXIDIZER	Strong oxidizer, moderately toxic.	*External*--Wash skin with soap and water.
Manganous Sulfate	10/1/1/---	Tissue irritant.	*External*--Induce vomiting and seek immediate medical attention.
Mercurous/ Mercuric Nitrate	2/1/1/OXIDIZER	Same as mercury compounds. Also is a fire hazard with organic compounds.	*External*--See mercury metal under First Aid. *Internal*--Do not give emetic if solution is acidic.
Mercury Compounds	Highly toxic. 8/1/2/POISON B	All are considered poisonous and harmful by swallowing, inhaling, or absorbing through the skin. Vapor, dust, solutions, and solids are all to be handled with caution. Suspected teratogen. Also, fire hazard with organic materials.	*External*--See mercury metal under First Aid. *Internal*--Seek immediate medical attention.
Mercury, Metal	WARNING! Vapor harmful. Avoid breathing vapor. (Keep small quantities in locked cabinet.) 8/1/2/ORM-B	Both vapor and liquid are poisonous. Contact with skin should be avoided because absorption and continuous exposure to vapor can be harmful. Suspected teratogen. Disposal requires an Extremely Hazardous Waste Permit.	*External*--No specific treatment for mercury poisoning except the administering of chelating agents to speed the elimination of mercury from the body. Wash skin with soap and water. *Internal*--Induce vomiting, unless person is comatose, convulsing, or has lost gag reflex.
Methanol	DANGER! Flammable. Vapor harmful. May be fatal if swallowed. Cannot be made nonpoisonous. 7/1 or 2s/2/FLAMMABLE	Flammable; poisoning may occur from ingestion, inhalation, or absorption through the skin. Can be lethal. Can cause blindness, metabolic acidosis.	*External*--Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*--Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Methyl Cellulose	7/1/2/ORM-E		
Methyl Ethyl Ketone	WARNING! Flammable. Keep away from heat and open flame. Keep container closed; use with adequate ventilation. Avoid prolonged or repeated contact with skin. 7/1 or 2/2/FLAMMABLE	Flammable. Dangerous fire risk. Narcotic by inhalation.	*External*--Wash with soap and water and seek medical attention. *Internal*--Seek immediate medical attention. *Inhalation*--Move to fresh air. Seek immediate medical attention.
**Methylene Chloride	Dispose of /PVC coated glass bottle/2/ORM-A	Central nervous system effects; narcotic in high concentration. Carcinogen.	*External*--Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
*Nickel (powder)	1/1/3/POISON B	Suspected carcinogen. Dust can be harmful to eyes, skin, lungs, and nose. Solids and solutions can be harmful if swallowed. Some compounds are acutely toxic.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
Nickel Chloride (crystals)	10/1/1/OXIDIZER	Toxic; avoid dispersal. Irritating to eyes and mucous membranes. Alleged carcinogen.	*External*--Irrigate eyes and skin with water. Seek medical attention. *Internal*--Treat vomiting as needed. *Inhalation*--Move to fresh air. Seek medical attention.
Nickel Nitrate	Avoid contact with combustibles. Oxidizer. Avoid contact with skin and eyes. 2/1/1/OXIDIZER	Oxidant; fire and explosion risk in contact with organic material.	*External*--(Same as Nickel, powder) *Inhalation*--Move to fresh air.
*Nicotine	8/1/1/POISON B	Toxic in contact with skin. If swallowed, can be fatal. Teratogen.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Nitric Acid	WARNING! Causes burns. Avoid contact with skin and eyes. Avoid breathing vapor. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 6/1/2/CORROSIVE<40%<OXIDIZER	Severe skin burns. Tissue damage if swallowed. Dental erosion; nasal and lung irritant.	*External*--Flush with water for 15 minutes. *Internal*--Maintain respiration. Seek immediate medical attention.
Oxalic Acid	WARNING! Harmful if swallowed. Causes skin irritation. Avoid breathing dust. Avoid contact with skin and eyes. Do not take internally. Keep away from feed or food products. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 10/1/3/CORROSIVE A	Dangerous when inhaled, swallowed, or absorbed through skin contact.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
Oxygen gas	Store away from any source of heat or flame. 9a/cylinder/3/NONFLAMMABLE/(OXIDIZER)	Supports combustion.	
Paraffin Wax (fumes)	10/Original Container/3/FLAMMABLE SOLID	Flammable. Toxic.	*Internal*--For inhalation of fumes, remove to fresh air. Maintain respiration. Seek medical attention.
Pentane	7/1 or 2S/--/FLAMMABLE	Flammable. Toxic.	*External*--Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
**Perchloric Acid	Warning! Strong oxidant. Corrosive liquid. Contact with combustible material may cause fire or explosion, especially if heated. Keep container closed and away from combustible material, dehydrating agents, and heat. Do not get in eyes or on skin or clothing. In case of spillage, flush with plenty of water and remove contaminated clothing and flush skin with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. Dispose of/--/--/OXIDIZER	Powerful oxidizer; unstable. Corrosive to tissue. Contact can cause irritation, severe pain, and burns. Forms unstable peroxides. Highly reactive.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Petroleum Ether	7/1 or 2S/3/FLAMMABLE	Flammable. Central nervous system depressant.	*External*--Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*--Maintain respiration. Seek immediate medical attention.
*Phenol (carbolic acid)	DANGER! Rapidly absorbed through skin. Causes severe burns. Do not get in eyes, on skin, or on clothing. Avoid breathing vapor. Do not take internally. In case of contact, immediately remove all contaminated clothing, including shoes, asnd flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. 10/1/1/POISON B	Suspected teratogen. Severe burn and tissue damage; toxic. Phenol in contact with more than 100 square inches of skin (10"x10") is absorbed so quickly through the skin as to be fatal in 90 seconds--unless quickly washed off with copious amounts of water.	*External*--Wash with water; then neutralize with sodium bicarbonate. Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
**Phosphorus (yellow or white)	DANGER! Causes severe burns. Contents packed under water and will ignite if water is removed. Do not get on skin or in eyes. Wear heavy rubber gloves and goggles or face shield. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. Keep can out of sun and away from heat. Dispose of /--/--FLAMMABLE	Flammable; spontaneously ignites on contact with air at 30° C. Causes severe skin burns. Poisonous if swallowed or smoke from burning is inhaled. Toxic. Disposal requires an Extremely Hazardous Waste Permit	*External*--Flush with water for 15 minutes. Treat splattered phosphorus with 2% solution of copper sulfate and keep skin area wet until medica l attention is obtained. Seek immediate medical attention. *Internal*-- Force vomiting immediately. Seek immediate medical attention. Do not administer alcohol, digestible fats, oil, or mineral oil as they enhance absorption.
*Phosphorus (red)	Flammable solid 1/2/1/FLAMMABLE	Yields very toxic fumes on burning. Avoid contact with oxidizers. Explosions have been known to result. Dangerous fire risk; skin contact may cause burns.	*External*--Flush with water for 15 minutes. Treat splattered phosphorus with 2% solution of copper sulfate and keep area wet until medical attention is obtained. Seek immediate medical attention . *Internal*-- Force vomiting immediately. Seek immediate medical attention. Do not administer alcohol, digestible fats, oil, or mineral oil as they enhance absorption
**Picric Acid (moist)	Dispose of (Call appropriate district personnel and local fire department.)	Primary explosive, especially when dry. Powerful oxidizer, unstable. Flammable. Toxic.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Potassium Bromide	10/1/2/POISON B	Toxic by ingestion and inhalation.	*Internal*--Induce vomiting and seek immediate medical attention. *Inhalation*--Move to fresh air.
Potassium Chlorate	WARNING! Contact with combustible material may cause fire. All clothing contaminated with chlorates is dangerously flammable. Remove and wash thoroughly with water. Do not get on floor. Spillage may cause fires with combustible material. Sweep and remove immediately. When not in use, keep tightly closed in original metal container. Keep away from fire. Store separately from flammable material. 2/1 or 2/3/OXIDIZER	Explodes easily (with shock or heat). Poisonous dust is irritant to lungs; harmful to skin and eyes. Reacts explosively with hydrocarbons such as kerosene. Detonates if ground with mortar and pestle. Use large rubber stopper.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
Potassium Chloride	10/1/1/---		*Internal*--Induce vomiting and seek immediate medical attention.
Potassium Chromate	2/1/3/ORM-E	Corrosive action on skin and mucous membranes. Toxic by ingestion and inhalation. Fire may produce irritating or poisonous gas. Alleged carcinogen.	*External*--Wash skin with water. Irrigate eyes with water for 15 minutes. *Internal*--Do not induce vomiting. *Inhalation*--Move to fresh air.
Potassium Dichromate	WARNING! Harmful dust. May cause rash or external ulcers. Keep container closed. Avoid contact with skin and eyes. Avoid breathing dust or solution spray. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. Use fresh clothing daily. Take hot shower after work, using plenty of soap. 2/1 or 2/3/ORM-A	Dust is primary irritant to eyes, skin, and lungs; harmful if swallowed. Can cause severe burns. Suspected carcinogen.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.

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Name	Label	Hazard	First Aid
Potassium Hydroxide	WARNING! Causes severe burns to skin and eyes. Avoid contact with skin, eyes, and clothing. Do not take internally. When handling, wear goggles or face shield. When making solutions, add potassium hydroxide slowly to surface of solution to avoid violent splattering. In case of contact, immediately flush skin with plenty of water and wash with vinegar; for eyes, flush with plenty of water for at least 15 minutes and get medical attention. 4/1/3/CORROSIVE	Caustic.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
Potassium Iodide	10/1/1/---		*Internal*--Induce vomiting and seek immediate medical attention.
**Potassium, Metal	Keep away from water and handle with dry utensils. Must be stored in dry oil. Dispose of/1KM/1/FLAMMABLE	Causes severe burns on contact with skin. Ignites spontaneously in moist air. Explosive and flammable. Water reactive.	*External*--Use 1-2.5 percent stearic acid in mineral oil to coat metal. For skin and eye contact, do the same and follow with water flush. Seek immediate medical attention.
Potassium Nitrate	2/1/2/OXIDIZER	Dangerous fire hazard and explosion risk when shocked or heated in contact with organic materials.	*Internal*--Induce vomiting and seek immediate medical attention.
Potassium Permanganate	Wear face protection. 2/1/3/OXIDIZER	Strong skin irritant. Explosion may occur if brought in contact with organic or other readily oxidizable substances.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
Propane	9b/Cylinder/3/FLAMMABLE	Flammable. Narcotic in high concentrations.	*External*--Ventilate area.
Resorcinol	10/1/3/ORM-E	Irritating to skin and mucous membranes.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
Silver Nitrate	WARNING! May cause burns. Avoid contact with skin and eyes. In case of contact with eyes, flush with water for at least 15 minutes and get medical attention. 2/1 amber glass/3/OXIDIZER	Silver nitrate causes caustic, poisonous burns. Skin irritant. Keep away from eyes.	*External*--Wash skin with water. Immediate treatment with sodium thiosulfate will prevent black stains from forming. *Internal*--Give emetics such as salt water. Seek immediate medical attention.
**Sodium Azide	Dispose/1/3/POISON B (Explosive)	Toxic. Very unstable and explosive. Keep away from heavy metals. Explodes when heated.	*External*--Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.
Sodium Chlorate	WARNING! Contact with combustible materials may cause fire. All clothing contaminated with chlorates is dangerously flammable. Remove and wash thoroughly with water. Do not get on floor. Spillage may cause fires with combustible material. Sweep up and remove immediately. When not in use, keep tightly closed in original metal container. Keep away from fire. Store away from flammable material. 2/2/3/OXIDIZER	Keep away from organic matter or other oxidizable substances. May explode if heated with organic matter. Toxic.	*External, Internal*--May cause local eye, skin, and nose irritation.
Sodium Chromate	2/1/2/ORM-E	Toxic by ingestion. Corrosive. Alleged carcinogen.	*External*--Irrigate eyes/skin with copious amounts of water for at least 15 minutes. Seek immediate medical attention. *Inhalation*--Move to fresh air. Seek medical attention.
Sodium Hydroxide	WARNING! Causes severe burns to skin and eyes. Avoid contact with skin, eyes, and clothing. Do not take internally. When handling, wear goggles or face shield. When making solutions, add sodium hydroxide slowly to surface of solution to avoid violent splattering. 4/1/2/CORROSIVE	Caustic, hazardous liquid. Eye and skin irritant. Inorganic bases can form explosive peroxides.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Neutralize with vinegar. *Internal*--If ingested, DO NOT induce vomiting. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
Sodium Hypochlorite (less than 7% chlorine)	2/1/2/ORM-B	Caustic, poisonous, irritating to the skin and readily gives up chlorine. Inhalation may produce severe bronchial irritation. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention. DO NOT induce vomiting.
Sodium Metal	DANGER! Reacts violently with water liberating and igniting hydrogen. May cause burns. Keep from any possible contact with water; store under oil. Keep container tightly closed. Do not get in eyes or on skin. Wear goggles and dry gloves when handling. In case of fire, smother with dry soda ash--never use water or chemical fire extinguishers. 1/1KM/2/FLAMMABLE/WATER REACTIVE	Flammable, corrosive solid. Reacts violently with water, causing fires and explosions. Disposal requires an Extremely Hazardous Waste Permit.	Skin--Remove sodium and flush affected area with water. Eyes--Immediately flush eyes with plenty of water for 15 minutes. Get medical attention.
Sodium Nitrate	2/1/3/OXIDIZER	Can be explosive if heated to 1000° F (537° C), can be detonated by shock or friction. Toxic by ingestion.	*Internal*--Induce vomiting and seek immediate medical attention.
Sodium Peroxide	WARNING! Strong oxidant. Causes severe burns to skin and eyes. Wear goggles or face shield when handling. Avoid spillage. Avoid any contact with skin or clothing. Sweep up spilled material with dry sand and flood with water in the open. Keep container tightly closed at all times. Store in a cool, dry location away from acids or combustible materials. Dissolve carefully; always add the sodium peroxide to the liquid. Avoid contact with any combustible matter. In case of fire, smother with dry sand. Use a dry powder fire extinguisher (for class D fires). Do not use water unless fire continues; then flood with large quantities from a hose. 2/2/2/OXIDIZER	Absorbs water from the air. Ignition and explosion may take place on contact with organic matter, metallic or non-metallic dust. Irritant and corrosive. Disposal requires an Extremely Hazardous Waste Permit.	*External*--Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*--Maintain respiration. Seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
Sodium Silicate	10/2/3/---	Irritating; caustic to skin and mucous membranes.	*External*--Wash with water for 15 minutes. *Internal*--Give water and induce vomiting. Seek medical attention.
Sodium Thiosulfate	10/1/1/---	Moderately toxic. Saturated solution breaks containers when crystalizing. May cause container to explode.	*External*--Wash skin/eyes with water for 15 minutes. *Internal*--Give water and induce vomiting. Seek medical attention.
Styrene	CAUTION! Vapor harmful. Keep away from heat and open flame. Use only with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/2S/--/FLAMMABLE	Flammable. May be irritating to eyes, mucous membranes, and skin in high concentrations.	*External*--Flush eyes with water for 15 minutes. Wash skin with soap and water. *Inhalation*--Remove to fresh air. Avoid prolonged breathing. Seek medical attention. Maintain respiration. *Internal*--DO NOT induce vomiting. Seek medical attention.
Sulfur	10/2/3/ORM-C	Combustible; may be irritating to skin and mucous membranes.	*External*--Flush eyes with water. Wash skin with soap and water. Remove persons who show allergic reactions.
Sulfuric Acid	DANGER! Causes severe burns. Do not get in eyes, on skin, or clothing. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Do not add water to contents while in a container because of violent reaction. 5/1/2/CORROSIVE	Dangerously corrosive chemical; hazardous liquid; eye, skin, and respiratory tract irritant. Absorbs water with violent reaction and heat.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Seek immediate medical attention. DO NOT induce vomiting. Maintain respiration. Seek immediate medical attention.
Toluene	WARNING! Flammable. Vapor harmful. Keep away from heat and open flame. Keep container closed. Use only with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/1 or 2S/2/FLAMMABLE	Poisonous and flammable liquid. Central nervous system depressant. Vapors and liquid irritating to eyes. Suspected teratogen.	*External*--An exposed person should be removed immediately to fresh air and kept warm and quiet. Seek medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

Name	Label	Hazard	First Aid
1, 1, 2-Trichloro- 1, 2, 2-trifluorethane (TTE)	10/1/3/ORM-B	High concentration can lead to asphyxiation. May be body tissue irritant.	*External*--Irrigate skin/eyes with water. *Inhalation*--Move to fresh air. Seek immediate medical help.
Turpentine	7/2S/3/FLAMMABLE	Flammable liquid. Irritating to skin, mucous membranes. Can cause severe kidney infection.	*External*--Ventilate area. *Internal*--DO NOT induce vomiting. Seek immediate medical attention.
Xylene	WARNING! Flammable. Keep away from heat and open flame. Keep container closed. Use with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/2S/2/FLAMMABLE	Flammable liquid. Suspected teratogen. May be narcotic in high concentration. Toxic by ingestion and inhalation.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Seek medical attention.
Zinc, Metal Powder	1/1/2/FLAMMABLE SOLID	Dust is combustible. Irritating to skin and mucous membranes.	*External*--Irrigate eyes with water. Wash skin with soap and water. *Internal*--Seek medical attention.
Zinc Nitrate	2/1/3/OXIDIZER	Moderately toxic. Strong oxidant; fire risk.	*External*--Irrigate eyes for 15 minutes and seek medical attention. *Internal*--Do not induce vomiting. *Inhalation*--Move to fresh air and seek immediate medical attention.

* Hazard risks outweigh their educational value. Districts are advised to make their own decisions.
** Dispose of immediately!

POTENTIALLY HAZARDOUS CHEMICALS PRODUCED IN LABORATORY EXPERIMENTS[a]

Name (common or other)	Notes	Hazards	Incompatible substances or conditions	First aid
Acetylene	Avoid silver or copper containers. Produced from reaction of calcium carbide and water.	Toxic when inhaled. Causes asphyxiation in high concentrations. Flammable.	Chlorine, bromine, copper, fluorine, silver, mercury.	Ventilate area.
**Ammoniacal silver nitrate	Produced in qualitative analysis of silver. Do not store in schools. Call appropriate agency for immediate disposal if present.	Explosive.		External--Flush with water.
Ammonium chloride	Produced from a reaction of hydrogen chloride and ammonia.	Nuisance dust.	Alkalies, metals, and their carbonates; and lead and silver salts.	External--Flush with water.
Amyl acetate	Produced in ester experiment.	Flammable.		External--Flush with water.
n-Butyl acetate		Flammable. Significant inhalation may cause breathing difficulty.		Internal--Seek immediate medical attention.
Chlorine		Dangerous to inhale. Can cause fatal lung and respiratory tract damage.	Acetone, ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals.	External--Flush with water.
Chromium Oxide Cr_2O_3	Produced in ammonium dichromate reaction.	Primary irritant to eyes and lungs.		External--Flush with water.
Esters		Flammable mixture. Alcohol-acid mixture should not be heated over an open flame.		External--Flush with water.
Ethyl acetate	Produced in ester experiment.	Flammable.		
Hydrogen		Flammable or explosive when mixed with air and exposed to a spark.		Ventilate area.
Hydrogen chloride		Dangerous to inhale. Damaging to respiratory tract. Concentrated solution may cause severe burns.		External--Ventilate area. Irrigate eyes with water. Internal--Maintain respiration. Seek immediate medical attention.

*Often considered more hazardous than their educational value. Districts are advised to make their own decisions.
**Dispose of immediately.
[a]It is assumed that the quantities of these materials produced will be minute (enough to test for presence) and/or used up in a secondary reaction. In any case, they should all be appropriately disposed of rather than stored.

Name (common or other)	Notes	Hazards	Incompatible substances or conditions	First aid
Hydrogen sulfide*	Produced from reaction of metallic sulfides and acid.	Flammable. Extremely poisonous. May cause headache, dizziness, and nausea after exposure to even low concentrations. Olfactory paralysis.	Fuming nitric acid, oxidizing gases.	Ventilate area. If breathing stops, give artificial respiration. Seek immediate medical attention.
Magnesium oxide dust	Forms when magnesium is burned.	Absorbs water and carbon dioxide from the air to form magnesium hydroxide.		External--Irrigate eyes with water. Wash skin with soap and water.
Methyl acetate	Produced in ester experiment.	Flammable. Irritating to respiratory tract in high concentrations.		External--Flush with water. Internal--Seek immediate medical attention for respiratory irritation.
Nitrogen dioxide	Forms from reaction with nitric acid and metals.	Strong oxidizer. Lung inflammation, which may lead to death.	Supports combustion of carbon, phosphorus, and sulfur	External--Ventilate area. Internal--Maintain respiration. Seek immediate medical attention.
Nitrogen triiodide*	Should never be prepared.	Highly explosive on contact with any moving solid objects. Self-reactive.		
Nitrous oxide	Should never be prepared.	Strong anesthetic properties.		Ventilate area if accidentally prepared.
Ozone	Formed in high voltage environment, such as electronic stencil cutter.	Powerful oxidizing agent. In high concentrations, irritating and injurious to respiratory tract and eyes.		Internal--Seek medical attention for respiratory irritation.
Phosphorous pentoxide	Formed by burning phosphorus in air.	Strong irritant. Corrosive to skin, mucous membranes, and eyes. Intensively absorbs water from the skin.	Moisture.	External--If burned, seek immediate medical attention.
Sulfur dioxide	Formed by burning sulfur in air.	Intensely irritating to respiratory tract and eyes.		Ventilate area. External--Flush with water.

*Often considered more hazardous than their educational value. Districts are advised to make their own decisions.
**Dispose of immediately.
[a]It is assumed that the quantities of these materials produced will be minute (enough to test for presence) and/or used up in a secondary reaction. In any case, they should all be appropriately disposed of rather than stored.

8. *Use and Disposal of Ethers*

The use of ethers for instructional purposes can present a danger to students and school staff members. The most common types of ethers used in high schools are diethyl ether (anesthetic ether) and petroleum ether. Petroleum ether is not a true ether but is a very volatile fraction of petroleum made up of pentanes and hexanes. Petroleum ether can also be known as ligroin or benzine.

Anesthetic ether which has been stored for several years can form crystalline solids, called ether peroxides, on the inside lid of the container. Once peroxides have formed, this diethyl ether is dangerously explosive.

The following procedures should be closely followed in any use of anesthetic ethers:

a. *Ordering*

- Order only as much diethyl ether as you will use for the school year because exposure to air causes the formation of peroxides that are explosive and sensitive to heat.
- Order diethyl ether only. Other types of ethers are not to be used in schools.

b. *Storage and Inventory*

- Date each container when received.
- Use oldest cans first.
- Use entire can of ether as soon as possible after seal is broken.
- Never store ether in glass container.
- Never store diethyl ether for more than 12 months.
- Store ether in a cool, dark location.
- Never store ether in a refrigerator, unless the refrigerator is certified explosion proof.
- Never open a container of ether if the age or condition is uncertain. Any shock or vigorous motion could cause an explosion. Do not open cap or stopper because this motion could be sufficient to cause an explosion.

c. *Class Use of Ether*

- Use only in cases where no alternative solvent is available.
- Never have an open flame or spark source in a room where ether is being used.
- Keep work area well ventilated.
- Use minimal quantities.
- Remember that ether vapor is heavier than air. The hazardous area is made greater because vapors spread along the floor.

d. *Ether Spills*

- Ventilate and evacuate the area.

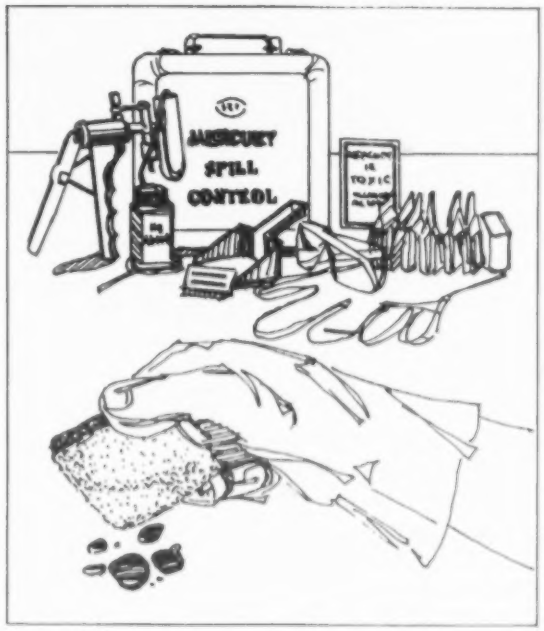
e. *Disposal of Ether*

- For any old, rusty, swollen, or suspect container of diethyl ether, immediately call the appropriate district staff member or local fire/county sheriff's department, as noted on the inside front cover of this handbook.
- For diethyl ether less than 12 months old, place opened container under fume hood or outdoors and allow to evaporate.

9. *Mercury*

Teachers should use the smallest quantity of metallic mercury possible to perform the experiment. Heat should be kept away from mercury at all times. Care should be taken that mercury is not put into any sink. All spills should be properly noted, in writing, and carefully cleaned up.

Mercury, if used, must be cleaned up as thoroughly as possible to reduce the long-term presence of mercury vapors in the classroom or preparation area.



The following instructions are given in the National Science Teachers Association pamphlet entitled *How to Provide for Safety in the Science Laboratory:*

- Spilled mercury should be collected with a vacuum suction bottle or a so-called mercury magnet, which is a spiral of copper wire treated with nitric acid and then amalgamated. This device will pick up even the tiniest droplet.

- Ordinary vacuum cleaners must not be used for picking up mercury, because mercury droplets will then be dispersed more finely throughout the laboratory.

- Perhaps one of the most commonly used devices for picking up spilled mercury is a glass tube about 6 mm diameter drawn out to an opening of about 1 mm and connected by rubber tubing to a filter flask connected with a vacuum aspirator; the flask acts as a trap.

The author of an article entitled "Chemistry Laboratory Safety Check" in the October, 1976, issue of *The Science Teacher* magazine quotes another source as follows:

> "For very small droplets [of mercury] or those that may have fallen into cracks in the laboratory bench or floor, Steere suggests that the vapor pressure of mercury may be lowered by treating the spillage with zinc dust to form an amalgam. Treatment with flowers of sulfur has been found to be ineffective."

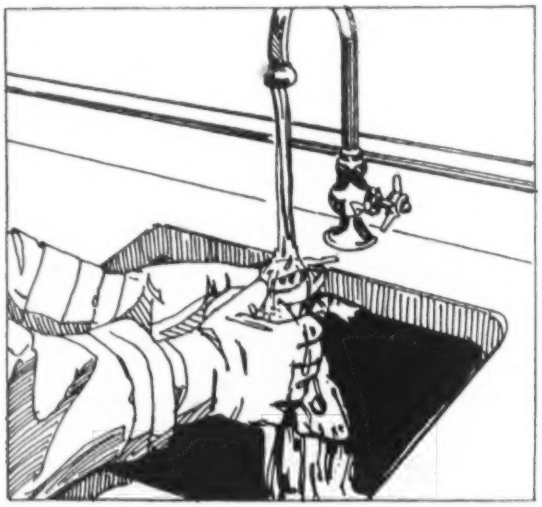
10. *Asbestos-Containing Substances*

Asbestos-covered wire gauze heating "pads" are no longer available commercially and should not be used in schools. Newer materials of ceramic, silica-base, or synthetic fiber are now used to coat wire gauze and other laboratory heat-resistant equipment. The newer materials generally give better heat-resistant qualities and also are less subject to chemical damage than the earlier asbestos types. After use, these new materials often appear like asbestos. Permanent marking, such as wires or staples on the edge, is recommended. Asbestos gloves or other soft or crumbly materials should be removed for disposal. ASBESTOS IS A RECOGNIZED CARCINOGEN. ASBESTOS FIBERS ENTER THE BODY BY INHALATION. AVOID ANY USE OF ASBESTOS.

11. *Formaldehyde*

- Formaldehyde and formalin solutions should be used only in chemistry laboratory experiments where the use of formaldehyde is essential.

- Some larger dissection specimens may have been originally (commercially) preserved using formalin, then washed and transferred to a less hazardous medium for shipping. All such specimens should be soaked for 24 hours in water prior to use and occasionally during use as residual formalin is exposed. The contaminated rinse water may not be poured down the sink unless you have obtained permission from your local sewage district authority.



- Formaldehyde solutions may be used for preserved specimens in a reference collection. Such specimens should not be removed for student use.
- Provide ventilation when working with rinsed formaldehyde specimens.
- Quantities of formaldehyde in excess of absolute need should undergo proper disposal.
- Formaldehyde spills should be thoroughly and completely cleaned up.

D. *Safety in the Physics Laboratory*

In addition to the following safety practices, physics teachers should be familiar with all other sections of the handbook pertinent to their instructional program. Special attention is directed to the section entitled Laboratory Safety Precautions--General Information.

- In wiring an electric circuit, make the live plug-in, or turn-on switch connection, the last act in assembling and the first act in disassembling. This is applicable to all portable electrical apparatus. All a.c. circuits above 12 volts should be shielded to avoid direct contact.
- When using an electric current, avoid bringing both hands in contact with live sections of the circuit. If possible, use only one hand at a time in all manipulations involving an electric circuit.
- Electrical cords and extension cords used in the classroom should be inspected regularly for defects in insulation or connections. All extension cords should be the heavy-duty, three-wire, grounded type. Extension cords should never be used to permanently connect electrical equipment.
- If electric current is constantly used near any metal object, the object should be permanently protected with an insulating cover to avoid possible contact. General care should be observed to see that live wires do not contact grounded metallic objects.
- Multiple plugs shall not be used in electrical wall outlets. Semipermanent electrical connections shall not be made to wall outlets. Under no circumstances shall a motor requiring a starting current of more than 20 amps be connected to a wall outlet.
- During the charging of a student-made wet storage cell, students should be kept away from the fine spray which develops. It is harmful if inhaled or allowed to get on the skin or in the eyes.
- Teachers and students should observe care in the handling of a lead/ acid or similar storage battery. It is a source of danger in spite of its low voltage because of the acid it contains and because of the very high current which may be drawn from it on a short circuit. Battery sparks have enough energy to ignite flammable vapors. Charging of storage batteries should be done only in a well-ventilated space. Hydrogen gas which is potentially explosive, is produced during charging.
- Induction coils of any type should be clearly marked for low-voltage and high-voltage connections in order to avoid the possibility of shocks.
- Instructors and students should at all times be shielded during the use or production of X-rays, microwaves, lasers, and from ultraviolet apparatus.

- In the handling of electronic equipment by teachers and students, the following precautions should be observed:

  - Make certain that the current is off before putting hands into a radio or any electronic equipment.

  - Be sure that there is a bleeder (high resistance) across the output of a power supply; otherwise, a severe shock from a charged condenser may result.

  - Exercise extreme caution in demonstrating, adjusting, or using image tubes of television receivers or cathode ray oscilloscopes when these tubes are removed from their protective housing. Such tubes should be removed only when necessary to the experiment.

- In evacuating a bulb during the density of air experiment(s), wrap it in a towel to avoid flying glass if the bulb should be crushed. Also, use round-bottom flasks for the process; they are stronger than the flat-bottom variety.

- In using a pressure cooker to demonstrate the variation of boiling points with pressure, be sure to examine the safety valve before use to make sure it is in working order. Also, do not allow the pressure to exceed 20 pounds per square inch.

- Caution should be observed in the use of all rotating apparatus such as the whirling table, Savart's Wheel, siren disk, centrifugal hoops, etc. Make certain the safety nut is securely fastened at all times. The apparatus should revolve at moderate speeds only.

- Care should be taken to prevent injuries from the sharp edges on mirrors, prisms, and glass plates. They should be inspected before they are handed to students, and sharp edges removed by grinding them with emery cloth or Carborundum stone, or painting the edges with quick-drying enamel. Students should be instructed to report at once any sharp-edged apparatus.

- The practice of removing thermometers, glass tubing, etc., from rubber stoppers as soon as possible after use will reduce the likelihood of the rubber adhering to the glass. To remove thermometer, rod, or glass tubing which has been "frozen" in a rubber stopper:

  - Use a wet cork-borer, just large enough to slip over the tubing, and slowly work the cork-borer through the stopper, thus boring the frozen tube out of the stopper.

  - As an alternate method, it is suggested that the rubber stopper surrounding a "frozen" thermometer be slit open with a single-edge razor blade or razor knife.

1. *Electrical Devices and Connectors*

The use of electricity can present a serious hazard in the classroom or laboratory. Electrical devices used in the laboratory or classroom should be listed by Underwriters Laboratory or equivalent for 110 volt outlet application or devices using 6 volt or 12 volt direct current furnished by batteries.

Electrical devices should never be used nor placed near any source of water or in any area subject to wetting from any source. Special care should be exercised in the placement and use of aquariums, particularly if these use a 110 volt light source.

Students should be cautioned that any projects they submit cannot be accepted unless they meet the specifications above.

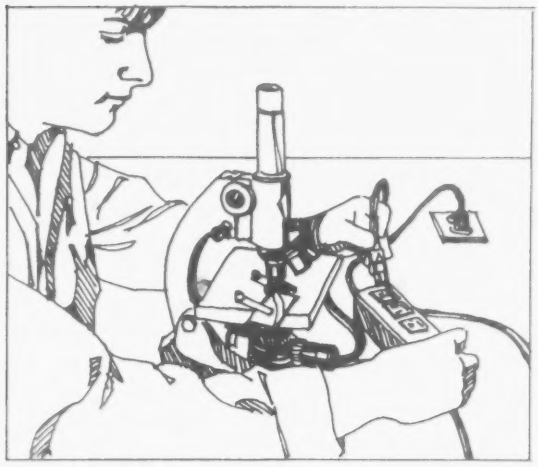
Following are some guidelines for safety in the use of electrical equipment:

- 110 volt Underwriters Laboratory or equivalent listed devices are recommended.

- Six (6) volt or 12 volt direct current is recommended for all possible applications.

- Operate electrical devices with dry hands and in a dry location.

- Be sure the floor is dry. Never stand on metal or any other conducting surface when using electrical devices.



- Never allow yourself to become part of an electrical circuit intentionally or unintentionally!
- Power equipment or devices must be "double insulated," or they must be safely grounded (three-pronged plug) by a competent electrician.
- Use extreme care with aquaria when they have an electrically operated pump and/or electrical light source.
- Extension cords should be used with extreme caution and should never be allowed to lie across areas of foot traffic.
- Be sure multiple-outlet "bars" have fuse protection or other circuit breaker.

For a more extensive safety treatise on the use of electrical apparatus and electric equipment in the classroom, refer to *Safety in the Secondary Science Classroom*, National Science Teachers Association, pp. 71-76.

In compliance with Section 2395.44, Title 8, *California Administrative Code*, Electric Safety Orders, exposed noncurrent-carrying metal parts of cord and plug-connected equipment which are likely to become energized shall be grounded. This includes motor-driven equipment and hand tools, time clocks, fans, lamps, vacuum cleaners, and similar equipment as well as those types of heating devices having exposed heating elements. Heating appliances having a metal frame must be grounded. Heating appliances having Cal-rod type fully enclosed elements do not require grounding.

It is also required that all nonportable electric devices be plugged directly into permanent electrical outlets rather than into extension cords.

2. *Model Rocket Launching on School Sites (See also Appendix III-D-3.)*

California state fire laws permit the launching of model rockets on school sites, provided the following safety precautions are followed:

- Launchings should be limited in number by teacher's prudent judgment if an audience of students is present.
- Only authorized classes or clubs should engage in this type of activity on school sites.
- Application for special permit may be required by local fire protection agencies. If a permit is issued in the name of the school administrator, it is also incumbent upon the instructor to comply with all safety standards. The school administrator should determine compliance.
- Rocket length must not measure less than 10 inches (25 cm) or exceed 15 inches (38 cm).
- Only Class A or smaller engines are recommended.
- Minimum size of the launch site for Class A or smaller engines should have a radius of 100 feet (30 m) from the firing position.

- No fire hazard can be posed by the launch. This means no dry vegetation or forest areas may be within the launch radius.

- No buildings, other structures, roads, or high voltage electrical lines may be within the launch radius.

- The firing area should be at the center of the launch radius. In no case should it be closer than 25 feet (8 m) to the boundary of the launch site.

- Teachers should caution their students regarding the dangers of experimentation with rockets and missiles, especially as applied to preparation and use of noncommercial rockets and propellants. Teacher must refrain from:

  - Providing chemicals for rockets or missiles or helping students to obtain them

  - Using, or permitting to be used, liquid or solid fuels in the classroom, as such use constitutes essentially a controlled explosion

  - Permitting construction of rockets, missiles, or component parts in the classroom or shop

  - Allowing students too close to the firing area

  - Launching other than commercially produced rocket engines of known size and predictable range

3. *Equipment Hazards—Lasers*

Science teachers should be aware of the inherent dangers to personnel which accompany the operation of lasers. Their use in demonstrations or in research activities must be preceded by orientation of all involved personnel to the potential hazards.

a. *Eye Hazards (See Use of Goggles and Safety Shields, page 80.)*

Perhaps the greatest danger is accidentally focusing the laser beam on the eye. Even low-power beams may burn the retinal area, producing a blind spot. If the retinal area irradiated is the macula, its fovea (area of extremely fine vision) or the optic nerve, then severe permanent visual damage may result.

b. *Skin Hazards*

The effects here are basically those of burns. Lighter skin with little melanin pigment is affected to a lesser degree, whereas skin with high melanin content —overall, or in spots, such as moles— may be burned severely.

c. *Laser Safety*

It is important that the teacher be aware of the output power rating of the laser being used. The Bureau of Radiological Health (BRH) of the Food and Drug Administration has established regulations for laser manufacturers effective August 2, 1976. Most lasers in use in secondary schools are continuous-spectrum, helium-neon Class II or Class IIIa lasers. Class II lasers (conforming with BRH specifications) may not exceed 1.0 milliwatt power and must contain a pilot light and a mechanical beam shutoff. Conforming

Class IIIa lasers must not exceed 5.0 milliwatt power and, in addition to a pilot light and mechanical beam shutoff, must contain a key switch and a connector for optional remote control operation.

For lasers purchased prior to August, 1976, the optical power specification is not a reliable index of the output. Tests have shown that pre-August, 1976, lasers rated at 1.0 milliwatts radiated in the range of 0.19 to 3.0 milliwatts. Laser hazards may be avoided by implementing the following measures:

(1) *Avoid direct viewing of the beam.*

Direct propagation of the laser beam from the laser into the eye of an observer should be avoided at all times. As a general practice, do not place any portion of the body in the beam. This practice becomes increasingly important as the output power of the laser device increases. Good work practices, developed early, will later assist the individual in working safely with higher output units.

(2) *Remove unnecessary objects from the path of the beam.*

Objects with mirrorlike finishes (e.g., plumbing fixtures) reflect laser beams. Viewing the reflected beams should be avoided. Demonstration equipment, such as support rods and bench surfaces, should be painted or treated to produce a dull, nonreflective surface. All optical components should be rigidly fixed with respect to their position relative to the laser.

(3) *Block the beam when it is not needed.*

The mechanical beam shutoff should be used to allow the beam to radiate *only* when necessary for measurements or observations.

(4) *Terminate laser beams.*

All laser beams should be terminated in a nonreflective, light-absorbing material.

(5) *Prepare and test demonstrations without others present.*

Demonstrations should be prepared and tested by the instructor without others present. The possibility of an unexpected reflection should always be considered.

(6) *Deflect beam in a vertical plane.*

Complex experiments or demonstrations involving reflection or refraction should be conducted with the beam deflection angles contained in a vertical plane. The laser display system should be contained in a box, open on the side(s), but closed on the ends, top, and bottom. The laser beam axis should be established at a level below or above the eye-level height of the instructor or observer.

(7) *Affix expanding lenses rigidly to the laser.*

When the laser is used to illuminate large surfaces, as in the viewing of holograms, beam-expanding (diverging) lenses should be rigidly fixed to the laser.

(8) *Equip laser with a key switch.*

The laser should be equipped with a key switch in the primary power circuit, rather than with the more commonly used toggle-type switch. Key switches are available from electronic supply stores for a relatively small charge. An additional switch which requires constant pressure is also desirable.

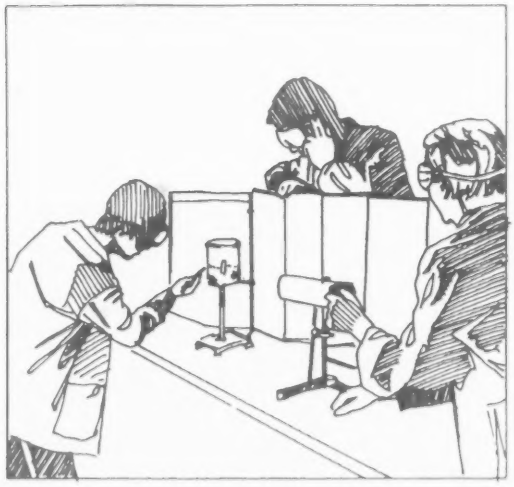
(9) *Do not leave an operable laser accessible and unattended.*

(10) *Reduce optical power.*

The optical power used should be reduced to the minimum necessary to accomplish the objective. Neutral density filters or colored plastic can be used effectively to reduce radiated optical power.

(11) *Keep the area well lighted at all times.*

This tends to keep the pupil of the eye relatively contracted and reduces the light impinging on the retina accidentally when the laser system is in use.



(12) *Provide and use adequate eye protection devices.*

Eye protection with shatter-resistant goggles is essential for some types of laser systems, but no one type of goggle offers protection for all wavelengths. Make sure that proper goggles are available and used.

(13) *Protect against electrical shock.*

The possibility of electrical shocks from both high-voltage and low-voltage equipment, including storage capacitors and power supplies, can be avoided by proper design.

(14) *Shield the pump source.*

High-intensity light generated by the pump source should not be viewed directly. Shielding is essential.

Lasers are valuable sources of light for exciting demonstrations and laboratory experiments in school.

Helium-neon lasers emit a beam of visible orange-light. Invisible, exotic, or otherwise harmful radiations are not emitted.

School lasers are low-power lasers. With a light output of only a few thousandths of a watt, these lasers should not be confused with the powerful lasers intended for burning, cutting, and drilling.

Even though the power of a laser may be low, the beam should be treated with caution and common sense because it is intense and concentrated. The greatest potential for harm with lasers is to the eyes. No one should look directly into the laser beam or stare at its bright reflections, just as no one should stare at the sun or arc lamps. Class II lasers have a maximum power of 1.0 mW, a power judged to be eye-safe, except possibly in the case of deliberate, long-term direct staring into the beam. Safety features include a pilot lamp which glows when the electrical power is "ON" and a mechanical beam stop which blocks the beam when the power is on.

The following steps can be taken to practice safety in the classroom:

- Instruct students not to look into the laser or stare at bright mirrorlike reflections of the beam.
- Block off the beam at a point beyond the farthest point of interest. Use a dull, nonreflective object, like a piece of wood.
- If the beam must travel a long distance, keep it close to the ground or overhead

so that it does not cross walkways at eye level.

Lasers with outputs greater than one milliwatt present additional hazards. Schools using such lasers might benefit from the following reference: *Safe Use of Lasers*, Z-136.1, 1986, American National Safety Institute, 1430 Broadway, New York, NY 10018; price $30 plus $5 shipping and handling.

d. *Electrical Safety*

Helium-neon lasers employ high voltages similar to that inside a small television receiver. Capacitors within the power supply retain the potentially harmful voltage for periods after the input power has ceased.

Each laser should be equipped with a UL-approved line cord and a three-prong grounded plug. ALWAYS PLUG THE LASER INTO A GROUNDED OUTLET.

e. *CDRH Regulations*

The United States Center for Devices and Radiological Health (CDRH) regulates the manufacturers of lasers to see that users are not endangered. The federal government classifies lasers according to their power levels and specifies appropriate safety features for each level. Demonstration lasers fall into Class II and can be identified by a yellow "CAUTION" label which contains the warning "Do not stare into beam."

Lasers must comply with the Laser Performance Standard of the U.S. Department of Health and Human Resources, and with Title 21, Part 1040 of the *Code of Federal Regulations* as it applies on the date of manufacture. These regulations classify lasers by beam power and specify safety features.

In addition to the CDRH label, each laser should have the following label placed near the beam exit: "Avoid exposure. Laser light is emitted from this aperture." The CDRH also requires that manufacturers provide users with the following information: "Caution--Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous light exposure."

IV. GENERAL LABORATORY PRACTICES

In addition to safe practices that are most appropriate to specific science laboratories, there are a number of general considerations. These include:

A. *Fire Prevention and Control*

In the event of a serious classroom fire, the teacher should conduct a fast, orderly evacuation of the room. The fire should be reported immediately, and control measures may be taken if the fire is localized and not presenting imminent danger. Both teacher and students should know the location of the nearest fire alarm, fire blanket, and extinguisher. The teacher should be knowledgeable in the use of these fire control devices.

When an open flame is used in the classroom, caution students to stay well away from that flame. Never reach across the flame area. In the event that hair or clothing becomes ignited, douse with water. A fire blanket can be used to smother the flaming area if water is not available in sufficient quantity. (See page 10 for fire blanket use.) Do not use a fire extinguisher on a person. Serious chemical burns or frostbite (in the case of CO_2 type) can result.

Many substances and types of chemical reactions involved in science programs present potential fire hazards. The teacher must anticipate the causes of fires and also be ready to act swiftly in the event that a fire should occur despite preventive measures which are taken.

The most common causes of fires in the science laboratory are:

- Failure to understand the nature of the supplies or equipment being used
- Careless handling of supplies or equipment

In an electrical fire, pull the plug if this can be done without sustaining a burn (cord might be hot) or becoming part of the circuit. Do not use water since it is a conductor of electrical current.

The following extinguishing procedures are recommended, depending on the type of fire encountered:

- Class A Fires. Fires in wood, paper, fabrics, and other common combustibles. Cool the fire with water or use a general-purpose dry chemical extinguisher (for use with all class A, class B, and class C fires).
- Class B Fires. Gasoline, oil, paint, alcohol, or other volatile, flammable liquids. Smother the fire, using CO_2, dry chemical, or foam extinguishers. Aim at the base of the flame with CO_2, and do not hold the nozzle (horn) because of frostbite hazard. Foam should be floated over the fire. Expel entire contents of extinguisher.
- Class C Fires. Fires in live electrical devices. Use a nonconductive substance to prevent yourself from becoming part of the electrical circuit. Use a CO_2 or dry chemical extinguisher. Shut off the electrical power if this is possible without sustaining a burn.
- Class D Fires. Combustibles, such as magnesium, titanium, potassium, sodium, zirconium, or other reactive metals. Special extinguishing powder. Do not use regular dry chemical extinguishers. Dry sand is effective on small class D fires. Call the fire department and inform them of the fact that this is a class D fire. Never use water or sand that is damp.

Multipurpose (2A-10BC) fire extinguishers are mandatory (*Title 19, California Administrative Code* Section 596.1). The State Fire Marshal requires that one extinguisher be provided for every 6,000 square feet (540 m^2) not more than 75 feet (22.5 m) away, on the same story or floor.

The following equipment items are recommended for use in the event of classroom fires:

- General purpose (ABC) dry chemical fire extinguisher. Not for use with class D fires.
- Carbon dioxide (CO_2) fire extinguisher. Not for use with class A or class D fires.
- Fire blanket for fires involving clothing of persons. Victim should stop, drop, and roll immediately on the floor to minimize inhalation of smoke or hot gases and be assisted in rolling up in the fire blanket, starting with the upper portion of the body, forcing any flames away from the head, yet making sure that the head is free.

B. *Use of Animals in the Classroom*

A science teacher or other qualified adult supervisor should assume primary responsibility for the conditions under which any study that involves live animals is conducted. If the school faculty does not include persons with training in the proper care of laboratory animals, the services of such a person on a consulting basis should be sought. Often, a local veterinarian may offer this kind of help.

All animals used must be lawfully acquired in accordance with state and local laws. All mammals used in a classroom should be inoculated for rabies, unless purchased from a reliable scientific company. All live-animal studies must be in compliance with *Education Code* Section 51540 (see page 80).

The following animals should never be brought into the classroom: wild birds and mammals, snapping turtles, poisonous snakes, or insects that may be carriers of disease. Students should not bring their pets to the classroom unless the activity is carefully planned by the teacher and approved by the administrator. Dead animals found by the side of the road should never be brought into the classroom, as they may carry hazardous bacteria or parasites.

Before a suitable small animal is brought into the classroom for observation, plans should be made for proper habitat and food. The living quarters of animals in the classroom must be kept clean, free from contamination, and secure enough to confine the animals. Plans must be made for care of classroom animals over the weekends and during vacation periods.

Animals should be handled only if it is necessary. This handling should be done properly according to the particular animal. Special handling is required if the animal is excited, is feeding, is pregnant, or is with its young.

Students should wash their hands after handling turtles, snakes, fish, frogs, toads, etc. Also, the water from the habitat should be disposed of carefully. Turtles should be purchased only from sources certifying that they are free of salmonella.

Students should be cautioned never to tease the animals or to insert their fingers or objects through wire mesh cages. Any student who is bitten or scratched by an animal should be sent immediately to the school nurse for appropriate treatment. After a period of animal observation is completed, animals should be returned to their natural environment.

1. *Humane Care and Treatment*

In biological procedures involving living organisms, species such as plants, bacteria, fungi, protozoa, worms, snails, arthropods, or insects should be used whenever possible. Their wide variety, ready availability in large numbers, and the simplicity of their maintenance and subsequent disposal make them especially suitable for student work. In mammalian studies, nonhazardous human experiments are often educationally preferable to those using species such as rats, guinea pigs, or mice.

No procedure shall be performed on any vertebrate animal that might cause it pain, suffering, or discomfort or otherwise interfere with its normal health. Therefore, no surgery shall be performed on any living vertebrate animal (mammal, bird, fish, reptile, or amphibian). No lesson or experiment shall be performed on a vertebrate animal that employs:

- Microorganisms which can cause disease in humans or animals
- Ionizing radiation
- Cancer-producing agents
- Chemicals at toxic levels
- Drugs that produce pain or deformity
- Extremes of temperatures
- Stressful electric or other shock
- Excessive noise
- Noxious fumes
- Exercise to exhaustion
- Overcrowding
- Other distressing stimuli

Animal observations must be directly supervised by a competent science teacher who shall approve the plan before the student starts work. Students must have the necessary comprehension and qualifications for the work contemplated. The supervisor shall oversee all experimental procedures, shall be responsible for their nonhazardous nature, and shall personally and continually inspect experimental animals during the course of the study (to ensure that their health and comfort are fully sustained).

Vertebrate animal studies shall be conducted only in locations where proper supervision is available, either in a school or in an institution of research or higher education. No vertebrate animal studies shall be conducted at a home (other than observations of normal behavior of pet animals such as dogs or cats).

In vertebrate animal studies, palatable food shall be provided in sufficient quantity to maintain normal growth. Diets deficient in essential foods are prohibited. Food shall not be withheld for periods longer than 12 hours. Clean drinking water shall be available at all times (and shall not be replaced by alcohol or drugs).

Chicken eggs subjected to experimental manipulations which may produce abnormalities shall not be allowed to hatch; such embryos shall be killed humanely no later than the eighteenth day of incubation. If normal egg embryos are to be hatched, satisfactory arrangements must be made for the appropriate care or humane relocation of chicks.

Projects involving vertebrate animals will normally be restricted to measuring and studying normal physiological functions such as normal growth, activity cycles, metabolism, blood circulation, learning processes, normal behavior, reproduction, communication, or isolated tissue techniques. None of these studies requires infliction of pain.

In many cases, the keeping of animals in the classroom can be conducive to the development of many learning situations. The humane care and handling of animals is paramount during such lessons. A respect for living things should be first in the mind of both the teacher and student. Respect for life shall be accorded to all animals, creatures, and organisms that are kept for educational purposes.

2. *Animal Use in Science Instruction*

State and local laws regulate the care and use of animals in secondary science instruction. The care and use of animals in California public school instruction are regulated by *Education Code* Section 51540, as follows:

> 51540. In the public elementary and high schools or in public elementary and high school school-sponsored activities and classes held elsewhere than on school premises, live vertebrate animals shall not, as part of a scientific experiment or any purpose whatever:
>
> (a) Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.
>
> (b) Be injured through any other treatments, including, but not limited to, anesthetization or electric shock.
>
> Live animals on the premises of a public elementary or high school shall be housed and cared for in a humane and safe manner.
>
> The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry.

Regulations pertaining to the use of animals in the classroom for educational purposes are also included in the *Health and Safety Code* of the state of California. These regulations primarily state that animals used for educational experimental purposes must be kept in satisfactory shelter, be humanely treated, be supplied with adequate food and water, and be kept in sanitary conditions.

The sections from the state of California *Health and Safety Code* that apply can be found in Appendix IV-B-2.

C. *Use of Goggles and Safety Shields*

1. *Eye Protection*

The following information is pertinent to eye protection in selected classrooms:

a. *Eye Safety*

Duties and responsibilities as required by law are summarized below (*Education Code* Sections 32030-33). (See Appendix I-E-3.)

(1) *District Governing Boards*

District governing boards should provide for the equipping of schools with eye protective devices for the use of all students, teachers, and visitors when participating in hazardous activities of the type outlined in Section b below.

(2) *Principals or Teachers*

Principals or teachers supervising any activity of the type outlined in Section b below should require that eye protective device be worn by students, teachers, and visitors.

b. *Circumstance Requiring Eye Protective Devices*

The eye protective devices shall be worn in courses which include, but are not limited to, vocational or industrial arts shops or laboratories and chemistry, physics, or combined chemistry-physics laboratories at any time the individual is engaged in an activity or is observing the use of hazardous substances likely to cause injury to the eyes. Such activity includes, but is not limited to, the following:

- Working with hot metal
- Working with hot liquids or solids or with chemicals which are flammable,

toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition, or other means

- Working with materials and/or equipment under stress, pressure, or forces which might cause fragmentation, including the use of hand or power tools against hard materials such as stone or metal

c. *Standards for Devices*

The eye protective devices used shall be of industrial quality which meets the standards of the American National Standards Institute for "Practice for Occupational and Educational Eye and Face Protection" (Z87.1-1979), and subsequent standards that are adopted by the American National Standards Institute for "Practice for Occupational and Educational Eye and Face Protection." Devices that meet the 1968 standards also meet the 1979 standards.

d. *Sale of Devices*

For students and teachers who wish to purchase their own eye-protective devices, these may be sold at a price which shall not exceed the district's cost. (See Appendix I-E-3, *Education Code* Section 32033.)

e. *Role of Guides, Handbooks, and Other Materials for Instruction*

Handbooks, guides, and other instructional materials designed for use by persons involved in direct supervision of hazardous situations as outlined above shall carry additional detailed guidelines covering specific subject areas and concerns.

2. *Eye Protective Devices*

Eye protective devices vary in form and effectiveness. Following are some of the specifications for such devices: Lenses must have minimum thickness of 3mm and be impact-resistant. Frames must be a lens-retaining type. Frames must be made of nonflammable material. Goggles must be of the splash-proof design.

Three basic types of eye/face protection are:

- Goggles—primarily intended for eye protection against impact and splash; these devices also serve to reduce the dust and fumes reaching the eye.

- Face shield—for partial personal face protection against splash or impact. Should ordinarily be used in conjunction with goggles.

- Safety shield—for group protection from splash and impact. Should be used with goggles and, if appropriate, with face shield.

Safety devices for eyes are recommended for the science program on the following basis:

Device	Recommended allowance
1. Goggles, plastic, splash-proof, vented (standard Z 87.1)	1. One class set of 35 for each school science laboratory. This number allows for visitors, breakage, and loss.
2. Goggles, plastic, splash-proof, nonvented	2. Five for each science laboratory.
3. Face shield, quick adjustable	3. One each teaching station, prep room, and project room.
4. Cabinet, germicidal, ultra-violet, capacity 35 goggles	4. One for each class set of goggles.
5. Shield, safety, flat	5. One for two classrooms.
6. Shield, safety, curved	6. One for two classrooms.

These devices should not be considered 100 percent effective against all potential eye hazards. Appropriate combinations of devices may be used for optimum protection.

In order to establish an effective eye safety program, the teacher must:

- Orient the students to the need for and use of eye protective devices.
- Warn students that contact lenses may not be worn in an atmosphere that may contain hazardous gases, vapors, or liquids, or when there is any danger of chemicals entering the eye (see box below).
- Consider eye safety when planning each science activity. Refer to First Aid--Eye Treatment (page 11) and Potential Eye Hazards (page 83). Ensure that all persons performing science laboratory activities involving hazards to the eyes wear approved eye protective devices. All persons in dangerous proximity to such activities must be likewise equipped.

Use of Contact Lenses

Because of capillary action of solutions which causes rapid spreading under contact lenses and possible delays in removal of the lenses, their use in science laboratory instruction is strongly discouraged except when essential to correct vision. Quick removal of contact lenses is very difficult under adverse conditions. It is essential that students, teachers, and visitors wearing contact lenses be promptly provided with approved nonvented protective goggles and that goggles be regularly worn. When laboratory activities are anticipated, prescription glasses should be worn, unless a student cannot see without contact lenses. Contact lenses are also not to be worn where a dust or vapor hazard exists, unless vapor-resistant goggles are available. If adequate eye protection cannot be provided, the students shall be excused from the activity and assigned to another supervised room or area.

- Establish routine procedures for the distribution of the individual eye protective devices when needed and for their subsequent return to the storage case.

- Establish a definite, readily accessible location in the designated areas for each type of eye protective device. An accessible germicidal, ultraviolet storage cabinet is an appropriate location for goggles, as it serves the dual purpose of storage and sterilizing.

- Maintain reasonable standards for cleanliness, since eye protective devices will usually be shared by several persons. Use of germicidal cabinets or dips is highly recommended along with frequent, thorough washing. Although these procedures do not "sterilize," they do sanitize, which is "safer" than no cleaning at all. Students with unhealthy, possibly contagious skin or eye conditions should be encouraged to purchase personal safety goggles, or a pair should be reserved for their exclusive use.

- Consider the special requirements of the storeroom, preparation room, and project room activities. Because of the greater probability and severity of many eye hazards in storerooms, preparation rooms, and project rooms, all persons performing or observing hazardous activities in these areas must be equipped with the splash-proof plastic goggles and other approved eye-safety devices specified for these areas.

3. *Potential Eye Hazards*

Eye protective devices must be provided for participants and observers in, but not limited to, the following situations:

a. *Impact Hazards*

- Pneumatic pressure or evacuation operations, including the pressure cooker
- Operation of power tools
- Operation of centrifugal (centripetal) devices
- Projectile and collision demonstrations
- Handling of elastic materials under stress; e.g., springs, wires, rubber, glass, etc.
- Working with or igniting explosive or implosive devices or substances
- Working with hot, molten metals

- Hammering, chipping, grinding rocks, minerals, and metals
- Cutting or breaking glass

b. *Hazardous Substances*

- Pouring, pumping, or dispensing corrosive substances
- Heating or electrolysis of chemicals
- Generation of toxic or potentially explosive gases
- Mixing chemicals which react violently
- Preserving and staining of biological specimens
- Cleaning and sterilizing with corrosive substances, including ammonia, detergents, or solvents

c. *Hazardous Radiation*

- Direct viewing of the sun. (Note: No approved eye protection is provided. *Do not allow this activity.*)
- Use of infrared and ultraviolet light sources. (Note: No approved eye protection is provided. These sources must be shielded from direct view.)
- Use of lasers. (Note: No approved eye protection is provided. These sources must be shielded from direct view. See Equipment Hazards—Lasers, page 73 and following.)

An effective eye protection program must include adequate instruction and demonstration concerning the hazards of laboratory work and the methods to avert accidental injury. This instruction must be repetitious and should become routine procedure. The eye protective devices must be readily available whenever needed, and high standards of cleanliness must be maintained to prevent any spread of infection from contagious eye or skin conditions. Students must be cautioned never to rub their eyes or touch their faces during any activity using reagents or substances which could be transferred via their hands. Students should scrub their hands thoroughly after any such laboratory exercise.

D. *Field Trips*

A first-aid kit (see Appendix IV-D-1) is required whenever a group takes a trip away from school. If the field trip is conducted into an area which is commonly known to be infested by poisonous snakes, be aware of precaution regarding poisonous snakebites in this handbook. Whenever a first-aid kit is used, the contents should be replenished, if necessary.

Students should be instructed as to the most appropriate types of clothing to wear on specific field trips. Students should be instructed to wash their hands and faces with a strong soap immediately after the trip as a precautionary measure against plant poisons.

Special precautions should be taken when trips are conducted on or near deep water. Special precautions should also be taken when trips are conducted into areas where coccidioidomycosis may be contracted from the dusty environment (see Appendix IV-D-2).

E. *Poisonous Plants and Plant Parts*

Biology and general science teachers should be prepared to caution students regarding the hazards of poisonous plants which grow in California. Special attention should be given poisonous plants or plants with poisonous parts which are (1) included as part of the school landscaping; (2) brought to school for plant studies; and (3) likely to grow in areas where field trips are planned.

Since *all* plants have not been thoroughly researched for their toxicity, a commonsense rule would be NEVER:

- Place any plant part in the mouth.
- Rub any sap or fruit juice into the skin or open wound.
- Inhale or expose your skin or eyes to the smoke of any burning plant or plant parts.
- Pick strange wildflowers or cultivated plants unknown to you.
- Eat food after handling plants, without first scrubbing your hands.

The reason for these "never" precautions is that any part of a plant can be relatively toxic, even to the point of fatality, depending on the weight of the person and the amount of the plant ingested.

Students frequently place seeds in their mouths, unconsciously. There is danger in this habit not only from swallowing a poisonous species but also from the practice of commercial distributors who coat their garden and crop seeds with hormones, fungicides, and insecticides. Some of these cause allergic skin responses. The remainder are usually deadly when inhaled to any degree or accidentally ingested. Teachers purchasing seeds from dealers for experiments should investigate the presence of any such coating or sprays and ask the dealer if they have been chemically coated.

Flower garden plants	*Toxic part*	*Symptoms*
Autumn crocus Star of Bethlehem	Bulbs	Vomiting and nervous excitement.
Bleeding heart (Dutchman's breeches)	Foliage, roots	May be poisonous in large amounts; has proved fatal to cattle.
Castor bean Rosary pea	Seeds	Fatal; a single rosary pea has caused death; one or two castor bean seeds are near the lethal dose for adults.
Daffodil Hyacinth Narcissus	Bulbs	Nausea, vomiting, diarrhea; may be fatal.
Dieffenbachia (dumb cane) Elephant ear Some philodendrons	All parts	Intense burning and irritation of the mouth and tongue; death can occur if base of tongue swells enough to block the air passage of the throat.

Flower garden plants	*Toxic part*	*Symptoms*
Foxglove	Leaves	One of the sources of the drug digitalis used to stimulate the heart; in large amounts, the active principles cause dangerously irregular heartbeat and pulse, digestive upset (usually), and mental confusion; may be fatal.
Iris	Underground stems	Severe, but not usually serious, digestive upset.
Larkspur	Young plants, seeds	Digestive upset, nervous excitement, depression; may be fatal.
Lily-of-the-Valley	Leaves, flowers	Irregular heartbeat and pulse, usually accompanied by digestive upset and mental confusion.
Monkshood	Fleshy roots	Digestive upset and nervous excitement.
Oleander *(See illustration below.)*	Leaves, branches	Extremely poisonous; affects the heart, produces severe digestive upset and has caused death.

Nerium oleander

Poinsettia	Leaves, flowers	Can be irritating to mouth and stomach; sometimes causes vomiting and nausea, but usually produces no ill effects.

Ornamental plants	*Toxic part*	*Symptoms*
Azaleas Laurels Rhododendron *(See illustration below.)*	All parts	Fatal; produces nausea and vomiting, depression, difficult breathing, prostration and coma.

Rhododendron

Cherries, wild and cultivated	Twigs, foliage	Fatal; contains a compound that releases cyanide when eaten; gasping, excitement, and prostration are common symptoms that often appear within minutes.
Daphne	Berries	Fatal; a few berries can kill a child.
Golden chain	Bean-like capsules in which the seeds are suspended	Severe poisoning; excitement, staggering, convulsions, and coma; may be fatal.
Jessamine	Berries	Fatal; digestive disturbance and nervous symptoms.
Lantana camara (red sage)	Green berries	Fatal; affects lungs, kidneys, heart, and nervous system; grows in the southern United States and in moderate climates.
Wisteria	Seeds, pods	Mild to severe digestive upset; many children are poisoned by this plant.
Yew	Berries, foliage	Fatal; foliage more toxic than berries; death is usually sudden, without warning symptoms.

Plants in fields	*Toxic part*	*Symptoms*
Buttercups	All parts	Have irritant juices that may severely injure the digestive system.
Jimson weed (thorn apple)	All parts	Abnormal thirst, distorted sight, delirium, incoherence, and coma; common cause of poisoning; has proved fatal.
Nightshade	All parts, especially the unripe berry	Fatal; intensive digestive disturbances and nervous symptoms.
Poison hemlock *(See illustration below.)*	All parts	Fatal; resembles a large wild carrot; used in ancient Greece to kill condemned prisoners.

Conicum maculatum L.

Plants in swamp or moist areas	*Toxic part*	*Symptoms*
Water hemlock	All parts	Fatal; violent and painful convulsions; a number of people have died from hemlock.

Plants in wooded areas	*Toxic part*	*Symptoms*
Black locust	Bark, sprouts, foliage	Causes nausea, weakness, and depression in children after they chew the bark and seeds.
Elderberry bark	Shoots, leaves	Children poisoned by using pieces of the pithy stems for blowguns; nausea and digestive upset.

Plants in wooded areas	*Toxic part*	*Symptoms*
Jack-in-the-pulpit	All parts, especially roots	Like dumb cane, contains small, needlelike crystals of calcium oxalate that cause intense irritation and burning of the mouth and tongue.
May apple	Apples, foliage	Contains at least 16 active toxic principles, primarily in the roots; children often eat the apple with no ill effects, but several apples may cause diarrhea.
Mistletoe	Berries	Fatal; both children and adults have died from eating the berries.
Moonseed	Berries	Blue, purple color, resembling wild grapes; contains a single seed (true wild grapes contain several small seeds); may be fatal.
Oaks	Foliage, acorns	Affects kidneys gradually; symptoms appear only after several days or weeks; takes large amount for poisoning; children should not be allowed to chew on acorns.
Poison oak *(See illustration below.)*	Leaves, stems, berries, roots	Skin contact with oily fluid secreted in all parts of plant causes painful, often long-lasting skin eruptions and a burning, itching sensation.

Rhus diversiloba

Vegetable garden plants	*Toxic part*	*Symptoms*
Rhubarb	Leaf blade	Fatal; large amounts of raw or cooked leaves can cause convulsions and coma, followed rapidly by death.

F. *Radiation-Producing Equipment and Materials*

Science teachers in secondary schools should be familiar with state regulations on the use of X-ray and radioactive materials to ensure safe use of radiation sources in science classrooms. The state publication *California Radiation Control Regulations*, which contains these requirements, may be obtained at a cost of $2.50 from the California Department of Health Services, Radiologic Health Branch, P.O. Box 1525, Sacramento, CA 95807.

1. *Radiation Machines*

Schools should not accept a gift of used or outmoded X-ray or microwave equipment until it is checked by a competent person (radiation safety officer or health physicist) to determine that the machine can be operated without excessive radiation leakage. Such used equipment may require modification for safe usage. Prior to acceptance and subsequent use of such equipment, schools should also be cognizant of the following state regulations:

a. *Section 25671, Article 5, Chapter 7 of California Health and Safety Code*

Pursuant to Section 25671, Article 5, Chapter 7 of California *Health and Safety Code:*

It shall be unlawful for any person to administer or use diagnostic or therapeutic X-ray on human beings in this state after July 1, 1971, unless such person has been certified or granted a permit pursuant to subdivision (b) or (c) of Section 25668 or pursuant to Section 25670, is acting within the scope of such certification or permit, and is acting under the supervision of a licentiate of the healing arts.

b. *California Administrative Code, Title 17, Health*

Article 1. Definitions

30100. *General Definitions.* As used in subchapter 4:

(y) "Radiation machine" means any device capable of producing radiation when the associated control devices are operated, but excluding devices which produce radiation only by the use of radioactive material. For fee purposes, when a radiation machine is equipped with two or more tubes that can be used separately for different purposes, each tube shall be considered as a single machine, except for machines used solely for research and teaching.

Article 1. Registration Procedure

30108. *Registration Requirement.* Every person possessing a reportable source of radiation shall register in accordance with the provisions of sections 30110 through 30146.

30125. Excluded Material and Devices. The following devices and materials do not require registration:

(a) Electrical equipment that produces radiation incidental to its operation for other purposes, but which does not produce radiation in any area accessible to individuals such that there is a reasonable likelihood that any individual will receive a radiation dose to the whole body, head, and trunk, gonads, or lens of the eye or active blood-forming organs in excess of 0.5 rem in a year.

2. *Radiation Hazards: Microwave Transmitters*

Microwaves, especially of high intensities, are strongly suspected of being significant health hazards. Until substantive data are available, teachers and students should avoid all unnecessary exposure, especially about the head at close range.

3. *Radiation Hazards: Cold Cathode Ray Tubes*

Cold cathode ray tubes of specific types commonly used in the classroom have been identified as potential sources of hazardous X-rays coincidental to their intended use. The following information was distributed by the California State Department of Public Health, Berkeley, California, dated September 11, 1969, and should be used by science teachers as guidelines in classroom use:

Cold cathode tubes are used for the study of electrons and electronic phenomena. These tubes come in a multitude of sizes, shapes, and forms. A recent U.S. Public Health Services study has shown that three of these types of tubes can produce potentially hazardous X-rays coincidental to their intended use. These are classified as:

- Heat Effect Tubes
- Magnetic Effect Tubes
- Shadow or Fluorescence Effect Tubes

The heat effect tube is used to demonstrate that cathode rays consist of rapidly moving electrons whose kinetic energy is converted to heat upon collision with an object. The tube consists of an evacuated glass bulb with a thin foil target positioned between opposed electrodes. The cathode has a concave surface to focus electrons on a small spot of the foil. The focal spot on the foil can easily be heated to a dramatically visible white heat.

The magnetic or deflection effect tube demonstrates that cathode rays carry an electric charge and can be deflected by a magnetic field. It consists of an evacuated glass cylinder with an electrode at each end. An aluminum strip coated with a fluorescent material is positioned between the electrodes. There is a collimating slit at the cathode end. In a magnetic field, the luminous line caused by electron bombardment of the fluorescent strip is moved up or down according to the polarity of the magnet.

The shadow or fluorescence effect tube demonstrates that cathode ray energy may be converted into visible radiation by fluorescence of the glass walls of the tube resulting from electron bombardment. A metallic object, such as a Maltese cross, is placed in a Crookes tube so that its shadow can be cast on the glass wall of the tube. From observation of this shadow, it can be shown that the cathode ray producing this pattern travel in straight lines.

These tubes can produce X-rays when all the following four conditions are met:

- An electron source or cathode is present.
- There is a target or anode which the electrons can strike.
- A high potential difference exists between anode and cathode. (In voltage of 10 KV or under, the electrons do not acquire sufficient energy to produce significant X-rays.)
- Low gas pressure prevails between cathode and anode, i.e., a moderately good vacuum exists in the tube.

With regard to X-ray production from the tubes under discussion, the following may be concluded:

- X-ray output is sporadic. Under identical conditions of operation, it may vary from one tube to another or from the same tube from day to day.
- Gas pressure within the tube is one of the controlling factors in X-ray production. If there is sufficient gas present, the accelerated electrons will collide with gas atoms and thus never gain enough energy to produce X-rays.
- Tube composition plays an important part in producing X-rays. X-ray production is a function of the target material the electrons strike.
- The tube wall, if thick enough and of proper composition, can act as a shield for X-rays.
- The output of the tube is strongly dependent upon the voltage and current capabilities of the power source.

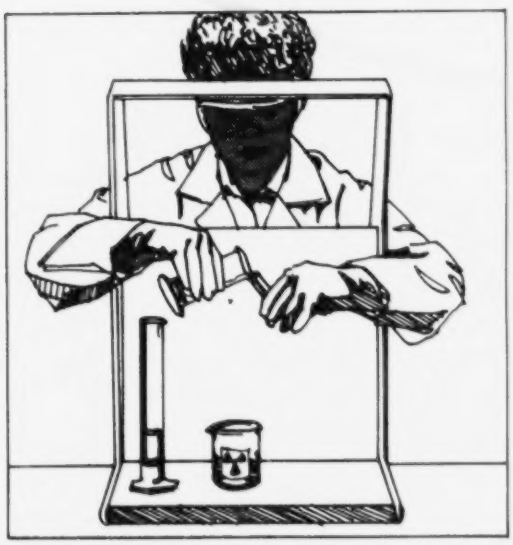
When using these tubes, the following procedures should apply:

- Tubes should be used only for demonstrations conducted by the instructor.
- Tubes should always be operated at the lowest possible current and voltage and the time of operation should be kept to a minimum.
- No student should stand closer than 10 feet (3 m) from a tube when it is operating.

G. *Radioactive Materials*

The details of this section were intended for situations in which individuals or groups actively participate in investigations or projects involving the use of radioactive materials. It does not refer to class demonstrations of the use of the radiation detector or cloud chamber.

The properties of radioactive materials are such that they have numerous applications in scientific research, in medicine, and in industry. It is anticipated that these applications will not only continue but also increase dramatically in number and in kind. The science program of districts should provide students with an opportunity to investigate radiological theory and uses of radioactive materials and to develop techniques and skills in handling such materials safely.



The use of radioactive isotopes in California is regulated by the U.S. Nuclear Regulatory Commission and by laws and regulations of the state of California. Teachers or other prospective users of radioactive isotopes should obtain the state of California publication "California Radiation Control Regulations" (CRCR). This publication may be acquired as indicated earlier, through the California Department of Health Services.

Science teachers in secondary schools who intend to use any radiation-producing equipment or materials must become familiar with California state regulations pertaining to the use of X-ray and radioactive materials. It is of the utmost importance that exposure of student, teacher, or other school personnel to any radioactive substance be minimized.

Regulations for the safe use of radioactive materials are contained in the *California Health and Safety Code*; the California Radiation Control Regulations (CRCR), *California Administrative Code*, Title 17.

Licensing requirements are listed in the California Radiation Control Regulations, *California Administrative Code*, Title 17. General licenses provided for in the regulation are effective without the filing of an application or issuance of license documents. Such licenses allow possession and use of limited quantities of radioactive materials, as specified by the regulation. All instructors using radioactive materials must conform to these licensing requirements.

Isotopes approved for use in schools are listed in CRCR, Title 17. No unsealed source of radium is permitted for school use unless authorized by the appropriate district staff member.

1. ***License Application Procedures for Procurement and Use of Higher Level Radioactive Materials***

CRCR, Title 17, contains the requirement for application for a specific license to procure and use *higher level* radioactive materials. All applications must be signed by the school site administrator or a designated representative. The administrator is directly responsible for the use and storage of such designated radioactive source material. A radiation safety officer with appropriate training must be specified.

A copy of the license must be sent to the appropriate district staff member. Complete inventory and use records must be maintained by the school and the appropriate district staff members. All conditions for safe handling and use of radioisotopes as established by the California Department of Public Health are contained in their handbook. All persons involved in the use of radioisotopes must have access to the laws and regulations as set forth in the *California Health and Safety Code*, *California Penal Code*, and *California Administrative Code*, Title 17.

2. *Procurement of Radioactive Isotopes*

All orders for radioactive isotopes must be processed with accurate records and approved by the appropriate district staff member.

Upon receipt of radioactive materials, the teacher shall:

- Inspect the package carefully for any breakage.
- Monitor the packing materials for any possible radioactive contamination. If evidence of any contamination exists, the appropriate district staff member or other appropriate agency must be notified immediately.
- Each container must be labeled with the following information:
  - That the package contains a radioactive substance
  - The chemical name of the material and its mass number
  - The date received and the name of the person responsible
  - The quantity of radioactive material (in microcuries) and the latest date of measurement

3. *Storage of Radioactive Isotopes*

All schools in which radioisotopes are stored must maintain an accurate and current record of the kind of substance, quantity, and date received. The inventory must be kept accurate and shall be reduced or removed when having been properly disposed of or when seven to ten half-lives have passed since the first measurement. Proper disposal procedures are discussed on page 94.

Facilities for school storage are the science storeroom or a lockable cabinet in a classroom. No more than ten scheduled quantities may be stored in any one school as specified in CRCR, Title 17. The only exception would be a specific authorization stated in the license issued for that particular isotope quantity. When

not in actual use, all radioactive materials must be in controlled storage as specified in CRCR, Title 17.

4. *Using Radioactive Isotopes*

The radiation symbol prescribed in CRCR should be displayed in any classroom or science stockroom where radioisotopes are stored or used. Normal, generally licensed quantities of radioisotopes do not warrant nor require the use of a dosimeter or badge. However, student activities involving handling low-level radioactive materials may be performed as though the materials are highly radioactive. This may provide valuable experience for subsequent activities at the university level or in vocations. Stringent precautions should be taken to ensure that no radioactive material has contacted the skin nor entered the mouth or respiratory passageways. Hands and body should always be checked with a Geiger counter after use of any radioactive materials.

Never handle a radioactive source with unprotected fingertips. Thin rubber gloves furnish protection against alpha-emitting substances. Beta emitters can be shielded by the use of glass or aluminum. The use of 12-inch (30-cm) tongs reduces the exposure dose. Normally licensed gamma-emitting materials should be handled in the same manner as are beta emitters.

No experiments should be performed which could cause the release of gaseous radioactive products. Exposure must be minimized and contamination avoided whenever radioisotopes are used. If even the slightest degree of contamination is detected, immediately notify the appropriate district staff member or other appropriate agency.

5. *Approved Disposal Procedures*

All liquid and solid radioactive wastes must be disposed of as specified in CRCR, Title 17. All waste disposal must be coordinated through the appropriate district staff member or other appropriate agency for disposal by persons holding a specific license for such disposal.

H. *Earthquake Preparation*

Earthquake! A strong 6.5 shaker smashes all the glass containers in your chemical storage area allowing them to intermix releasing toxic fumes and a corrosive slurry strong enough to eat through the flooring and cement.

This may sound unreasonable, but it actually happened at Coalinga High School in 1983. Consultant E. Robert Bulman concluded in his report, "The Coalinga Earthquake—A Report on Schools," that although our school buildings can structurally withstand a 6.5 earthquake, the shaking will cause tremendous amount of glass breakage, and, therefore, he recommends the following preventive measures: (a) toxic chemicals must be kept low and in chemical proof pans; (b) an acid-proof floor is needed; (c) an inventory of what is in the storeroom is needed; (d) the name of the nearest chemical burn center should be kept in the chemistry lab; and (e) disaster drills must be conducted more frequently.

In addition, Robert Vert, the acting superintendent of the Coalinga/Huron Joint Unified School District in 1983, offers the following insights:

1. "Chemicals must be properly stored, and not just alphabetically placed."

2. "Anchor your shelves, put on safety lips, and buy secure latches to keep the cupboards from flying open."

3. "Open shelving is inviting disaster."

If you doubt that the information in this section applies to you, read this sobering statement made by Bay Area Regional Earthquake Preparedness Project (BAREPP) in 1985:

> "Approximately 80 percent of California's population is located within the Uniform Building Code's highest seismic risk zone out of the five zones in the United States. The remainder of the state is located in the next highest zone. This translates to virtually a 100 percent chance of experiencing light shaking or worse during (the next) 25 years...."

As our urban areas become increasingly populated in the vicinity of hazardous earthquake regions, the resultant amount of death and destruction can be expected to rise.

I. *Developing an Earthquake Response Plan*

Given the aforementioned facts, California science teachers need to prepare now! Please read this entire section on seismic safety and then act!

The earthquake safety measures outlined in this section are intended to augment your school's general emergency/disaster plans. When considering seismic safety in science classes, the central components of any earthquake response plan should include, but are not limited to, the following four phases:

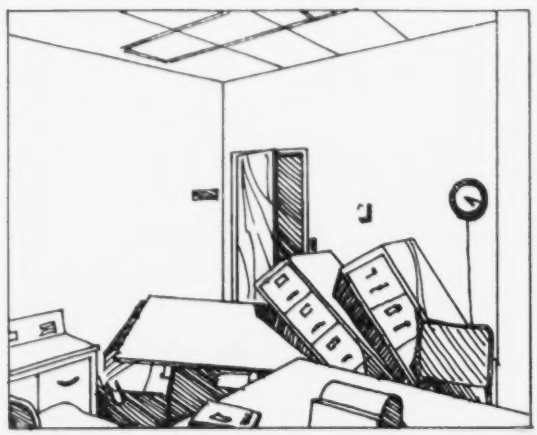
1. Surveying your classroom and stockroom for nonstructural hazards

2. Performing hazard reduction projects

3. Creating an earthquake response plan

4. Procuring emergency equipment and supplies

Completing these four phases will aid your school in coming into compliance with the requirements of the Assembly Bill 2786 (Chapter 1659, Section 40041.5, 1984; and Article 10.5, Chapter 2, Part 21, *Education Code*; Appendix I-E-5).



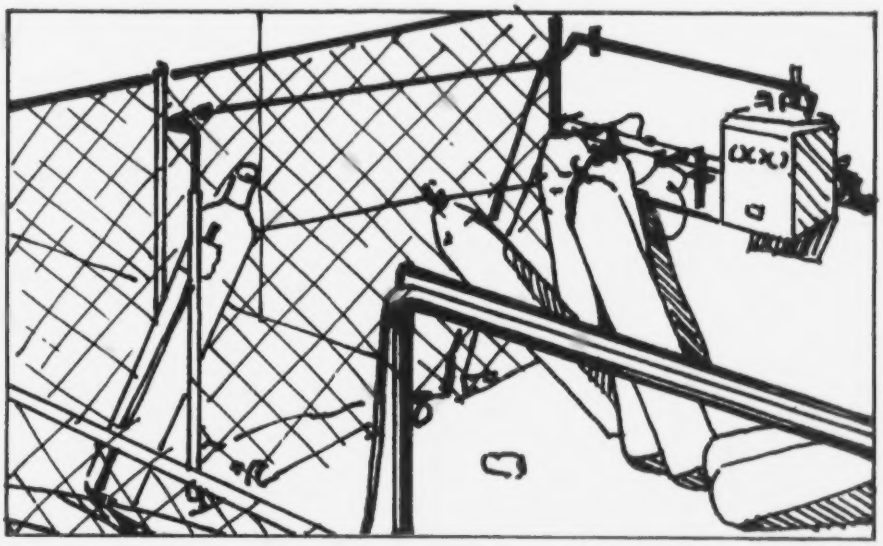
Phase 1-Nonstructural Hazard Identification

The checklist below is intended to help you identify common nonstructural earthquake hazards that can be reduced or eliminated at little or no cost. For questions you have checked "No," refer to Phase 2, Step 3, of this section to rectify your nonstructural hazards:

1. *Equipment/Furnishings/Fixtures*	*Yes*	*No*
a. Are free-standing cabinets, lockers, bookcases, cupboards, storage racks, and wall shelves secured to a structural support?	☐	☐
* b. Are the ceilings, overhead lights, movie screens, and air ducts secured to a structural support?	☐	☐
c. Do tall industrial storage racks have adequate bracing?	☐	☐
d. For racks significantly taller than wide, are large anchor bolt connections to the concrete slab present?	☐	☐
e. Is the TV monitor securely fastened either to a securely fastened platform or a cart with a low center of gravity and lockable wheels?	☐	☐
f. Do desk-top computers have secured monitors?	☐	☐
g. Are heavy or sharp wall decorations securely mounted (with closed eye-hooks for example)?	☐	☐
h. Have heavy objects stored above head level been relocated or restrained?	☐	☐
* i. Are refrigerators, water heaters, or ranges restrained by attachment to floor or wall and not just by kitchen cabinetry?	☐	☐
j. Is specialized heavy lab equipment (e.g., autoclave) placed on countertops secured for protection against sliding off and falling?	☐	☐
k. Are fire extinguishers securely mounted?	☐	☐
l. Are cabinets equipped with heavy-duty latches? (Magnetic catches can too easily pop open.)	☐	☐
m. Are display cases or aquariums protected against overturning or sliding off tables?	☐	☐
n. Are emergency battery-operated lights protected from falling off shelf supports?	☐	☐
* o. Are the fire sprinkler risers equipped with a v-brace to the wall, and are there large-diameter sprinkler pipes secured with diagonal braces to the structure above (See NFPA Standard Number 13)?	☐	☐
* p. Do sound system speakers in elevated locations have positive anchorages?	☐	☐
* q. Are suspended space heaters, especially gas-fired, braced and/or equipped with flexible gas connections?	☐	☐
r. Are hanging plants, movie screen, or displays fastened with closed-eye hooks and positioned so that they would not hit a window if they swung?	☐	☐
* s. Are air distribution grills or diffusers screwed to adequately supported sheet metal ducts, ceiling, or wall?	☐	☐
* t. Are large metal air distribution ducts, especially if they are suspended a few feet, fastened with diagonal bracing?	☐	☐

*Additional help from the janitor or maintenance person may be needed.

	Yes	No
* u. Is the suspended ceiling equipped with bracing wires? (See *Uniform Building Code* [UBC], Table 23-3 and UBC Standard #47-18.)	☐	☐
* v. Are the lay-in fluorescent light fixtures independently supported such that there are at least two hanger wires per light fixture?	☐	☐



2. *Hazardous/Toxic Materials*

a. Have inventories been made of hazardous chemicals so that someone can check on these chemicals after an earthquake?	☐	☐
b. Are compressed gas cylinders tightly secured with a nylon strap, a strong chain near the top and near the bottom, or stored on a rack designed to restrain cylinders?	☐	☐
c. Are laboratory chemicals on shelves restrained by a wire, lip, or other barrier?	☐	☐
d. Have your chemicals been stored by compatible groups to reduce the likelihood of their mixing and causing reactions?	☐	☐
e. Have chemicals been stored in plastic or other unbreakable storage containers?	☐	☐
* f. Does gas piping allow for movement where it connects to equipment which could slide, swing, or tip, or where piping crosses expansion joints structurally separating wings of a building?	☐	☐
* g. Are automatic gas shut-off devices that are sensitive to excess flow, leak detector actuated, or earthquake triggered?	☐	☐

3. *Windows*

* a. Have the windows in the classroom/stockroom or lab been equipped with safety glass or covered with protective film?	☐	☐

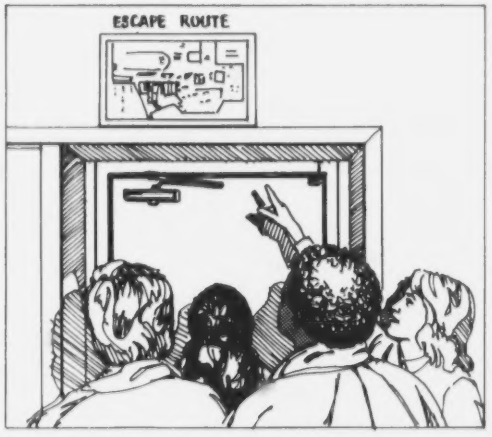
*Additional help from the janitor or maintenance person may be needed.

Phase 2--Hazard Reduction Projects

After identifying the nonstructural hazards in your classroom/lab/stockroom/prep room, the next step is to determine the most effective method to mitigate these risks.

- *The first step.* To establish an earthquake awareness program.

  Central to earthquake preparedness is the "earthquake drill" to teach students (and staff) how to RESPOND IMMEDIATELY with life-protecting action. Then conduct a follow-up discussion which will not only reinforce the idea of WHERE to seek shelter and HOW to protect themselves but also provide a forum to discuss the students' concerns and thus minimize the chance of panic if an actual earthquake occurs.



- *The second step.* Obtain or draw a map of the school and school grounds.

  This can be used to note potential hazards and the location of utilities, emergency equipment, and supplies. Moreover, it can provide the foundation for (a) tracing an evacuation route; (b) locating a safe assembly area; (c) creating your earthquake response plan (e.g., first aid, search and rescue, etc.); and (d) marking the location(s) of the following:

  1. Main shut-off valves for water and gas
  2. Electrical power master switch
  3. Stoves, heating/air-conditioning equipment
  4. Chemical storage and gas lines in laboratories
  5. Fire extinguishers
  6. First-aid equipment

- *The third step.* Mitigate the nonstructural hazards.

  To rectify each of the hazards that were identified in Phase 1, the following suggested methods are cross-referenced with the more common nonstructural hazards found in secondary science rooms:

  1. *Equipment/Furnishings/Fixtures*

     a. Anchor all file cabinets, shelving, bookcases to wall studs. (1-a, 1-c, 1-d)

     b. Check cupboards and cabinets for secure latches that would stay locked during an earthquake. (1-l)

     c. Anchor all desk-top computers, components, TVs, aquariums, plants, sound systems, lamps, or other miscellaneous heavy items. (1-e, 1-f, 1-i, 1-m)

     d. Remove or secure any boxes or equipment stored on top of high cabinets. (1-h)

     * e. Check the secure attachment of any *overhead* fixtures, decorations, lighting, grills in walls or ceiling panels or latticework. (1-b, 1-g, 1-n through 1-v)

     * f. Securely affix fire extinguishers in accessible areas. (1-k)

*Additional help from the janitor or maintenance person may be needed.

g. Put chocks under wheels of objects or wheels that lack built-in brakes. (1-e, 1-i)

* h. Restrain heavy equipment (e.g., refrigerators, ranges, etc.). (1-i, 1-j)

i. Post safety signs, symbols, and labels to reinforce safety precautions.

2. *Hazardous/Toxic Materials*

a. Secure compressed gas cylinders or large tanks, with store nylon strips or heavy-duty chains. (2-b)

b. Use wires or other barriers to restrain objects from falling from open shelving. (1-l, 2-c)

c. Store chemicals in unbreakable containers according to the compatibility system prescribed in this handbook (page 39), or one similar, in order to reduce the possibility of incompatible mixture. (2-d, 2-e)

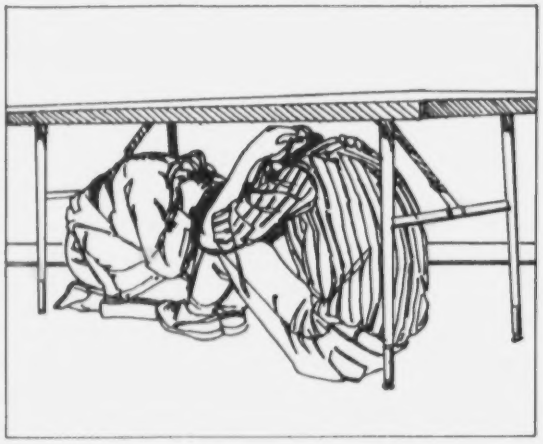
3. *Windows*

a. If the windows are not made of safety glass, a protective transparent film may be applied. Not only will this reduce the danger of flying glass but it also provides an additional security measure against break-ins. (3-a)

Phase 3--Creating an Emergency Response Plan (ERP)

Because of the passage of the Assembly Bill 2786 (Chapter 1659, Statutes of 1984, "Katz"), most schools have already developed an earthquake emergency procedure system that includes, but is not limited to, all of the following:

- A school building disaster plan
- A "duck and cover" (students duck under their desk, and cover their neck and head)



- Protective measures to be taken before, during, and after an earthquake
- A training program for both students and staff about your earthquake emergency procedure system

*Additional help from the janitor or maintenance person may be needed.

An excellent school guide to completing the above tasks was recently furnished to all schools by the Federal Emergency Management Agency (FEMA) entitled *Guidebook for Developing a School Earthquake Program.* If you need a free copy, contact the California Seismic Safety Commission at (916) 322-4917. If you need innovative curricular materials, contact CALEEP at Lawrence Hall of Science, University of California, Berkeley, CA 94720.

SELECTED CHEMICAL HEALTH AND SAFETY REFERENCES
(for Elementary and Secondary Teachers of Science)

Compiled by
Jay A. Young, Chemical Safety and Health Consultant

These five references are essential:

J. A. Gerlovich, and others. *School Science Safety*, Batavia, Ill.: Flinn Scientific, Inc., 1984.

In two volumes, one for elementary science, the other for secondary. Written to and for teachers. A practical, sensible, useful guide; one of the two best sources of information currently available to teachers.

School Science Laboratories, A Guide to Some Hazardous Substances. Compiled by the Consumer Product Safety Commission. Washington, D.C.: Consumer Product Safety Commission, 1984.

The other best reference for teachers. Loaded with practical suggestions. Example: A complete set of sensible, practical laboratory safety rules on pages 17 and 18.

Chemical Labels

Almost every reputable supplier of chemicals for the laboratory has prepared good labels. Read those labels; compare labels for the same chemical from different suppliers; discover which suppliers have labels with reliable precautionary information. Follow those precautions.

Material Safety Data Sheets

These two-page or more documents describe the hazardous properties and precautions during use that apply to a chemical. They are currently available from some suppliers on request at no cost. (By late 1985 all suppliers were required by federal regulations to provide material safety data sheets.) Be aware that some suppliers' data sheets will be more useful for the same chemical than those from other suppliers.

Hazards in the Chemical Laboratory (Third edition). Edited by L. Bretherick. London: Chemical Society, 1981. (Available in North America from Lab Safety Supply Co., Janesville, Wis.)

Considered to be the best reference available when it was published. A new edition soon is planned. Meanwhile, *School Science Safety* and *School Science Laboratories, A Guide to Some Hazardous Substances* are more directly useful.

These references should be in the school library for use by teachers and students:

Fire Protection for Laboratories Using Chemicals, also known as *NFPA-45*. Compiled by the National Fire Protection Association, Batterymarch Park, Quincy, Mass.: National Fire Protection Association, 1974.

The national safety code as it applies to laboratory fire prevention and protection.

"The Merck Index" (Tenth edition). Edited by Martha Windholz. Rahway, N.J.: Merck and Co., Inc., 1983.

Accurate descriptions of many of the hazardous properties of many chemicals, unfortunately not always describing all of the known hazardous properties. But, all in all, probably better than the so-

called "Chemical Dictionaries," lists of "Dangerous Properties," and so on, which may describe hazardous properties that a chemical does not possess.

NIOSH/OSHA Pocket Guide to Chemical Hazards Publication no. 78-210. Edited by F. W. Mackison and others. Compiled by NIOSH Division of Technical Services. Cincinnati: NIOSH Division of Technical Services, 1978.

A handy and accurate summary of the hazardous properties of chemicals for which OSHA has assigned permissible exposure limits as these were known in 1978. (It will almost fit in your pocket.)

D. A. Pipitone and D. Hedberg. "Safe Chemical Storage," *Journal of Chemical Education*, Vol. 59, A159 (1982).

Improper storage of chemicals, e.g., on the shelves in alphabetical order, probably has caused more property damage than any other single unsafe practice. This article describes how to do it properly.

Practice for Occupational and Educational Eye and Face Protection, Z 87.1. Compiled by the American National Standards Institute, New York, NY.

The standard for eye and face protection. Do not rely on any eye or face protection devices unless they meet this standard; all that do meet the current requirements are marked *Z87* on the device.

Prudent Practices for the Disposal of Hazardous Chemicals from Laboratories. Compiled by the National Academy of Sciences, Washington, D.C.: National Academy Press, 1983.

A useful book; how to properly dispose of hazardous waste chemicals. Very technical. Teachers may wish instead to use "Tox boxes" for simpler and legal disposal of hazardous chemicals. Tox boxes are available from the Lab Safety Supply Co. in Janesville, Wis.

NOTE: Do *not* rely on chemical disposal procedures described in the catalogs of some suppliers; many of those procedures violate current environmental protection laws and regulations.

K. M. Reese. *Health and Safety Guidelines for Chemistry Teachers.* Washington, D.C.: American Chemical Society, 1980.

Principally directed to college and university laboratories, but pages 9 and 12 on how to set up a laboratory safety program and "Thirty-Nine Steps for a Safer Laboratory" also apply to precollege laboratory instruction.

Safety in Academic Chemistry Laboratories (Fourth edition). Compiled by the Council Committee on Chemical Safety. Washington, D.C.: American Chemical Society, 1984.

A recognized classic authority.

Standard First Aid and Personal Safety. Stock No. 321116. Compiled by the American Red Cross. Available from local Red Cross chapters.

A well-known, standard reference. Local Red Cross chapters also usually have other programs dealing with first aid that teachers will find useful.

J. A. Young. "Risk Assessment and Hazard Evaluation for Undergraduate Laboratory Experiments," *Journal of Chemical Education*, Vol. 59, A265 (1982).

How to determine whether an experiment you plan to assign to your students is, or is not, "safe" for those students.

APPENDIXES

APPENDIX I-D-1

LIABILITY AND THE SCIENCE TEACHER*

A Self-Examination

"During the last few years teacher liability has been discussed in faculty lounges, staff meetings, and professional journals. By now, most teachers are aware of the factors that contribute to gross negligence and thus to liability for accidents that occur in the classroom or the field."

In each of the cases listed below a science teacher was being sued for liability. As a member of the jury, would you judge these teachers guilty or not? Assume that the relevant facts have been given. Place a check in front of each case in which you would vote for a guilty verdict. The answers will be given below.

1. A biology teacher requested a student to bring a glass beaker from the back of the room to his demonstration table. The student slipped and fell and received serious wounds from the broken beaker.

2. A student in a chemistry laboratory injured himself while inserting a piece of glass tubing into a rubber stopper. The teacher had previously demonstrated and properly instructed all the students concerning the method and danger involved. The student attempted to force the glass tubing into the stopper and was injured when the tubing snapped and went through the palm of his hand.

3. During a physics lab a teacher stepped out of the classroom for a few minutes to obtain a reference book from the library. In his absence, a serious accident occurred.

4. On a field trip a science teacher led his students across a precarious-looking footbridge. The bridge collapsed, causing serious injury to several students.

5. A teacher asked two students to clean a chemical stockroom, warning them of an unlabeled jar of acid on a high shelf. A scuffle caused the acid to fall, and the students were seriously burned.

6. A student was sent to the drugstore in his own car to purchase some hydrogen peroxide. While returning, he hit another car when he ran a red light. He had no insurance and the accident victim sued the teacher.

7. A student was asked to water the plants in the greenhouse lab adjoining the botany classroom. The student carried a glass full of water, tried to climb a chair, and was seriously injured when the chair collapsed. The chair was in good repair.

8. Three students in a chemistry class were making up a lab exercise on the preparation and properties of oxygen. The teacher told them to gather the materials necessary to the experiment and to follow the safety directions in the write-up. Contrary to the directions in the write-up, the students mixed potassium chlorate with red phosphorus and ferric oxide and heated them with a Bunsen burner. An explosion resulted and several students were injured.

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Answers:
The jury voted guilty in numbers three; four; six; and eight. Did you?

APPENDIX I-E-1

CALIFORNIA *EDUCATION CODE* SECTIONS ON HAZARDOUS MATERIALS EDUCATION

ARTICLE 4. HAZARDOUS MATERIALS EDUCATION

49340. This article shall be known and may be cited as the California Hazardous Materials Education Act of 1982.

49341. The Legislature hereby finds and declares as follows:

(a) Because school science laboratories pose a potentially serious threat to the health and safety of school pupils and school personnel due to the use and storage of hazardous materials in these laboratories, educational efforts are needed to increase the awareness of persons dealing with these materials in these settings so that possible losses of life, injuries, loss of property, and social disruption which could result from the improper and unsafe use of hazardous materials will be minimized.

(b) Effective safety in school laboratories requires informed judgment, decision making, and operating procedures by those responsible for laboratory and related instruction. It is desirable that each high school and junior high, middle, or elementary school offering laboratory work have a trained member of the professional staff who is designated as the building laboratory consultant and who *is responsible for the review, updating, and carrying out of the school's adopted procedures for laboratory safety.*

(c) Efforts by state and local agencies to implement training programs designed to provide qualified individuals with the necessary information, organizational skills, and materials to assist schools and teachers in the development of their laboratory safety policies and procedures are nonexistent or inadequate, and it is necessary that this situation be remedied. The state should assume leadership through the policy and guidance of the State Department of Education in the development, support, and implementation of a statewide training program.

(d) The Legislature requests that the Department of Education consider making this program a part of the department's energy and environmental education program which is conducted pursuant to Chapter 4 (commencing with Section 8700) of Part 6.

SECTION 2. Section 49401.5 is added to the *Education Code* to read:

49401.5. (a) It is the intent of the Legislature in enacting this section to express its concern for the health and safety of school pupils and school personnel at schools where hazardous materials are stored on the school premises, and to encourage school districts to take steps to ensure hazardous materials are properly used and stored.

(b) The governing board of any school district may request consultation services from the California Occupational Safety and Health Consultation Service to ensure hazardous materials are being used and stored safely in school laboratories.

SECTION 3. This act shall not be construed to impose any change in the duty of care required of school districts.

SECTION 1. Section 49411 is added to the *Education Code*, to read:

49411. (a) The State Department of Education, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall formulate, on or before July 1, 1985, *a listing of chemical compounds used in school programs which includes the potential hazards and estimated shelf life of each compound.*

(b) The Superintendent of Public Instruction, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall develop guidelines, on or before September 1, 1985, for school districts for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed. Each school district, on or before January 1, 1986, shall certify to the superintendent whether the district is in compliance with the guidelines.

(c) The county superintendent of schools may implement a system for disposing of chemicals from schools within the county or may permit school districts to arrange for the disposal of the chemicals.

SECTION 2. Notwithstanding Section 6 of Article XIII B of the California Constitution and Section 2231 or 2234 of the *Revenue and Taxation Code*, no appropriation is made by this act for the purpose of making reimbursement pursuant to these sections. It is recognized, however, that a local agency or school district may pursue any remedies to obtain reimbursement available to it under Chapter 3 (commencing with Section 2201) of Part 4 of Division 1 of that code.

SECTION 3. Notwithstanding Section 2231.5 of the *Revenue and Taxation Code*, this act does not contain a repealer, as required by that section; therefore, the provisions of this act shall remain in effect unless and until they are amended or repealed by a later enacted act.

GENERAL INDUSTRY SAFETY ORDERS

Article 110. Special Hazardous Substances and Processes

5194. Material Safety Data Sheets

(a) Scope and Application.

(1) This section applies to the following:

(A) Employers who use hazardous substances;

(B) Hazardous substances which are present in the workplace as a result of workplace operations in such a manner that employees may be exposed under normal conditions of work or in a reasonably foreseeable emergency resulting from workplace operations. A reasonably foreseeable emergency includes, but is not limited to, spills, fires, explosions, equipment failure, rupture of containers, or failure of control equipment which may or do result in a release of a hazardous substance into the workplace.

(2) The provisions of this section *do not* apply to the following:

(A) Products intended for personal consumption by employees in the workplace. These consist of items that satisfy human wants through their use, such as food or sanitary goods;

(B) Consumer products packaged for distribution to, and use by, the general public;

(C) Retail food sale establishments and all other retail trade establishments, exclusive of processing and repair work areas;

(D) The use of a substance in compliance with regulations of the Director of Food and Agriculture issued pursuant to Section 12981 of the *Food and Agriculture Code*;

(E) Laboratories not engaged in either production for commercial purposes or provisions of quality control analysis for production provided that the laboratory is under the personal supervision and regular observation of an individual who has knowledge of the *health risks associated* with the use of the particular hazardous substances involved;

(F) Impurities which develop as intermediate materials during chemical processing but are not present in the final product, and to which employee exposure is unlikely;

(G) A substance or form of substance as present occupationally which is not potentially hazardous to human health, as determined pursuant to the procedures of Section 337, Development and Maintenance of List.

(3) *Nothing in this section is intended to relieve an employer's duty to comply with the requirements of Section 3204.*

(b) Definitions.

(1) Act. Hazardous Substances Information and Training Act, Chapter 2.5 (commencing with Section 6360) of Part 1 of Division 5 of the *Labor Code*.

(2) Acute Health Effects. Health effects which are manifested immediately or shortly after, and as a result of, an exposure to a hazardous substance.

(3) Chronic Health Effects. Health effects which develop over a long period of time after, and as a result of, a single or repeated exposure to a hazardous substance.

(4) Expose or Exposure. Any situation arising from work operation where an employee may ingest, inhale, absorb through the skin or eyes, or otherwise come into contact with a hazardous substance; provided that such contact shall not be deemed to constitute exposure if the hazardous substance present is in a physical state, volume, or concentration for which it has been determined pursuant to Section 337 that there is no valid and substantial evidence that any adverse effect, acute or chronic, on human health may occur from such contact.

(5) Hazardous Substance. Any substance included in the list of hazardous substances prepared by the Director, Department of Industrial Relations, pursuant to *Labor Code* Section 6382.

(6) Impurity. A hazardous substance which is unintentionally present with another substance or mixture.

(7) MSDS (Material Safety Data Sheet). A document which supplies information about a particular hazardous substance or mixture, as required by *Labor Code* Section 6390. A label in 8-point or larger type, prepared pursuant to *Labor Code* Section 6390, shall constitute a MSDS for the purposes of this regulation.

(8) Mixture. Any solution or intimate admixture of two or more substances which do not react chemically with each other, at least one of which is a hazardous substance and constitutes 1% or more of the

mixture, unless specified at different concentrations by the Director, Department of Industrial Relations, pursuant to Labor Code Section 6383.

(c) Duties of Employers.

(1) Each employer shall have on hand, or shall have requested from the manufacturer, producer or any other seller of hazardous substance, a completed MSDS for each hazardous substance in use at the place of employment which has been supplied to the employer by such manufacturer, producer, or seller.

(2) Employers shall make available, on a timely and reasonable basis, a MSDS on each hazardous substance in the workplace upon request of an employee, collective bargaining representative, or the employee's physician.

NOTE: Section 3204 provides that any designated representative of an employee can request exposure records of the employee. Exposure records may include MSDS. Employers should also refer to Section 3204 concerning information to be retained after a particular substance is no longer in use.

(3) The employer may adopt reasonable procedures for acting upon such employee requests to avoid interruption of normal work operations.

(4) If the MSDS is not on hand, the employer shall:

(A) Within 7 working days of a request make written inquiry to the manufacturer, producer or seller of a hazardous substance or hazardous mixture responsible for the MSDS, asking that the MSDS be sent to the employer. If the employer has made written inquiry in the preceding 12 months as to whether the substance or product is subject to the requirements of the Act or the employer has made written inquiry within the last 6 months requesting new, revised or later information on the MSDS for the hazardous substance, the employer need not make additional written inquiry.

(B) Notify the requestor in writing of the date that the inquiry was made, to whom it was made, and the response, if any, received. Providing the requestor with a copy of the inquiry sent to the manufacturer, producer or seller and a copy of the response will satisfy this requirement.

(C) Notify the requestor of the availability of the MSDS within 15 days of the receipt of the MSDS from the manufacturer, producer or seller or provide a copy of the MSDS to the requestor within 15 days of the receipt of the MSDS from the manufacturer, producer or seller.

(D) If a response has not been received from the manufacturer, producer or seller within 25 working days of the date the request was made, send the Director, Department of Industrial Relations, a copy of the request with a notation that no response has been received.

(5) *Employers shall notify employees of hazardous substances present in their workplace.* Such notification shall consist of at least one of the following:

(A) Prominently posted list of hazardous substances which specifies the location and manner in which the MSDSs are available. If lists are posted in several places, the hazardous substances on any particular list need only pertain to those present in the immediate area of the posting.

(B) Prominently displayed binders containing the MSDS for hazardous substances in that recognized work area, provided that the number and location of binders is sufficient to give reasonable notice to all affected employees.

(C) *Any other appropriate method involving written notice listing the hazardous substances used in the work area, the availability and location of MSDSs on these substances, and reasonable timely access to MSDSs at the worksite.*

(d) Training and Information Program.

(1) *Employers shall furnish employees with an explanantion of what a MSDS is either in written form or through training programs.*

(2) Employers shall furnish employees who may be exposed to a hazardous substance with information on the contents of the MSDS for that hazardous substance, or equivalent information, either in written form or through training programs.

(A) Initial information or training shall be provided within 60 days of the effective date of this regulation. Thereafter, information or training shall be provided to an employee prior to assignment to an area in which there is the potential for exposure to a hazardous substance for which the employee has not received previous information or training.

(B) If a MSDS has not been received by 60 days of the effective date of this regulation, such information or training shall be provided on a timely and reasonable basis, not to exceed 30 days after receipt of a MSDS.

(3) When training employees who may be exposed to hazardous substances, the employer shall explain the following as outlined in the MSDS:

(A) Any health hazards associated with the use of the substance or mixture.

(B) Proper precautions for handling, necessary personal protective equipment or other safety precautions necessary to prevent or minimize exposure to the hazardous substance.

(C) Emergency procedures for spills, fire, disposal and first aid.

(4) Information provided in information and training programs may relate *to an entire class of hazardous substances* to the extent appropriate and related to the job.

(5) Whenever an employer receives a new or revised MSDS, such information shall be provided to employees on a timely basis not to exceed 30 days after receipt, if the new information indicates significantly increased risks to, or measures necessary to protect employee health as compared to those stated on MSDS previously provided.

(6) Employers shall inform employees of the right:

(A) To personally receive information regarding hazardous substances to which they may be exposed, according to the provisions of this regulation;

(B) For their physician or collective bargaining agent to receive information regarding hazardous substances to which the employee may be exposed according to provisions of this regulation;

(C) Against discharge or other discrimination due to the employee's exercise of the rights afforded pursuant to the provisions of the Act.

NOTE: Authority cited: Sections 142.3 and 6398, *Labor Code*. Reference: Sections 142.3, 6362, 6385, 6386, 6398 and 6399, *Labor Code*.

Section 5162. Corrosive Liquids.

(b) Employees shall be protected as required by Article 10 when engaged in any of the following operations.

(1) Using or handling in open containers corrosive liquids in quantities of one gallon or more.

(2) Withdrawing a corrosive liquid from a container designed to hold five gallons or more, or filling such a container.

(3) Unloading a corrosive liquid from a tank car or tank truck, or filling a tank car or truck with a corrosive liquid.

(c) Whenever any of the operations described in (b) are regularly or frequently performed, quick-acting deluge showers, and bubble-fountain or other method of simultaneously washing both eyes shall be provided.

(d) Protective equipment as described in Article 10 may be required where employees are regularly or frequently handling corrosive liquid in closed or covered containers, particularly if such containers are of glass.

(e) Where corrosive liquids are regularly or frequently handled in open containers or drawn from reservoirs or pipe line, adequate means shall be provided to neutralize or dispose of spills and overflows promptly and safely.

APPENDIX I-E-2

ASSEMBLY BILL 2185

An act to add Chapter 6.95 (commencing with Section 25500) to Division 20 of the *Health and Safety Code* relating to hazardous materials.

Legislative Counsel's Digest

AB 2185, M. Waters. *Hazardous Materials: Release Response Plans: Inventory.*

(1) Existing law provides for a governmental response to releases or threatened release of hazardous substances.

This bill would require every county to implement its provisions through a designated administering agency. A city could assume that responsibility within the boundary of the city, thereby imposing a state-mandated local program.

The bill would require any business, which handles a hazardous material, and is located within an implementing county or city, to establish a specified business plan by September 1, 1986, in accordance with standards adopted by the Office of Emergency Services, for emergency response to a release or threatened release of the hazardous material. A handler would be required to report certain releases or threatened releases, as specified.

The bill would also require the administering agency to establish an area plan for emergency response, as prescribed.

The bill would require any business which handles a hazardous material to annually submit a specified inventory to the administering agency, which information would be included in any business plan, and would provide for trade secret protection.

The bill would prescribe criminal penalties for violations of the above provisions, thereby imposing a state-mandated local program, authorize assessing the violator the cost of the emergency response and clean-up, require an implementing or threatened violations or an order directing compliance, and provide for the payment of rewards to informants under regulations adopted by the State Department of Health Services.

An implementing county or city would be authorized, upon vote of its governing body, to levy and collect fees to pay for certain costs incurred in carrying out these provisions.

(2) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement, including the creation of a State Mandates Claims Fund to pay the costs of mandates which do not exceed $500,000 statewide and other procedures for claims whose statewide costs exceed $500,000.

This bill would provide that no reimbursement is required for specified reasons.

APPENDIX I-E-3

CALIFORNIA *EDUCATION CODE* SECTIONS OF SPECIAL RELEVANCE TO SCIENCE EDUCATORS

Education Code sections that are of special significance to science educators appear below. Included are regulations pertaining to devices designed to protect the eyes, instruction in personal public health and safety, removal of chemicals, and emergency procedures for earthquakes and disasters.

32030. Duties Regarding Eye Protective Devices

It shall be the duty of the governing board of every school district, and community college district and of every county superintendent of schools, and of every person, firm, or organization maintaining any private school, in this state, to equip schools with eye protective devices as defined in Section 32032, for the use of all students, teachers, and visitors when participating in the courses which are included in Section 32031. It shall be the duty of the superintendents, principals, teachers or instructors charged with the supervision of any class in which any such course is conducted, to require such eye protective devices to be worn by students, teachers, or instructors and visitors under the circumstances prescribed in Section 32031.

32031. Courses in Which Devices to Be Used; Substances and Activities Dangerous to Eyes

The eye protective devices shall be worn in courses including, but not limited to, vocational or industrial arts shops or laboratories, and chemistry, physics or combined chemistry-physics laboratories, at any time at which the individual is engaged in, or observing, an activity or the use of hazardous substances likely to cause injury to the eyes.

Hazardous substances likely to cause physical injury to the eyes include materials which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition or other means as defined in the California Hazardous Substances Labeling Act.[1]

Activity or the use of hazardous substances likely to cause injury to the eyes includes, but is not necessarily limited to, the following:

1. Working with hot molten metal.
2. Milling, sawing, turning, shaping, cutting, grinding, and stamping of any solid materials.
3. Heat treating, tampering, or kiln firing of any metal or other materials.
4. Gas or electric arc welding.
5. Repairing or servicing of any vehicles, or other machinery or equipment.
6. Working with hot liquids or solids or with chemicals which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition, or other means.

[1] *Health and Safety Code* sections 28740 et seq.

32032. Standards for Devices

For purposes of this article the eye protective devices utilized shall be industrial quality eye protective devices which meet the standards of the American National Standards Institute for "Practice for Occupational and Educational Eye and Face Protection" (Z87.1--1968), and subsequent standards that are adopted by the American National Standards Institute for "Practice for Occupational and Educational Eye and Face Protection."

32033. Sale of Devices at Cost to Pupils and Teachers

The eye protective devices may be sold to the pupils and teachers or instructors at a price which shall not exceed the actual cost of the eye protective devices to the school or governing board.

51202. Instruction in Personal and Public Health and Safety

The adopted course of study shall provide instruction at the appropriate elementary and secondary grade levels and subject areas in personal and public safety and accident prevention, including emergency first-aid instruction, instruction in hemorrhage control, treatment for poisoning, resuscitation techniques, and cardiopulmonary resuscitation when appropriate equipment is available; fire prevention; the protection and conservation of resources, including the necessity for the protection of our environment; and health, including venereal disease and the effects of alcohol, narcotics, drugs, and tobacco upon the human body.

APPENDIX I-E-4

ASSEMBLY BILL 3820

CHAPTER 1107

An act to add Section 49411 to the *Education Code*, relating to schools.

AB 3820, Papan. Schools: removal of chemicals.

(1) Existing law does not require the removal of chemical compounds from schools.

This bill would require the State Department of Education, in cooperation with the Division of Occupational Safety and Health, to formulate a listing of chemical compounds used in school programs, as specified.

This bill would require the Superintendent of Public Instruction, in cooperation with the Division of Occupational Safety and Health, to develop guidelines for school districts for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed.

The bill would impose a state-mandated local program by requiring each school district to certify to the Superintendent of Public Instruction whether it is in compliance with the guidelines.

(2) Article XIII B of the California Constitution and Sections 2231 and 2234 of the *Revenue and Taxation Code* require the state to reimburse local agencies and school districts for certain costs mandated by the state. Other provisions require the Department of Finance to review statutes disclaiming these costs and provide, in certain cases, for making claims to the State Board of Control for reimbursement.

This bill would provide that no appropriation is made by this act for the purpose of making reimbursement pursuant to the constitutional mandate or Section 2231 or 2234, but would recognize that local agencies and school districts may pursue their other available remedies to seek reimbursement for these costs.

(3) This bill would provide that, notwithstanding Section 2231.5 of the *Revenue and Taxation Code*, this act does not contain a repealer, as required by that section; therefore, the provisions of the act would remain in effect unless and until they are amended or repealed by a later enacted act.

The people of the State of California do enact as follows:

SECTION 1. Section 49411 is added to the *Education Code*, to read:

49411. (a) The State Department of Education, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall formulate, on or before July 1, 1985, a listing of chemical compounds used in school programs which includes the potential hazards and estimated shelf life of each compound.

(b) The Superintendent of Public Instruction, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall develop guidelines, on or before September 1, 1985, for school districts for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed. Each district, on or before January 1, 1986, shall certify to the superintendent whether the district is in compliance with the guidelines.

(c) The county superintendent of schools may implement a system for disposing of chemicals from schools within the county or may permit school districts to arrange for the disposal of the chemicals.

SEC. 2. Notwithstanding Section 6 of Article XIII B of the California Constitution and Section 2231 or 2234 of the *Revenue and Taxation Code*, no appropriation is made by this act for the purpose of making reimbursement pursuant to these sections. It is recognized, however, that a local agency or school district may pursue any remedies to obtain reimbursement available to it under Chapter 3 (commencing with Section 2201) of Part 4 of Division 1 of that code.

SEC. 3. Notwithstanding Section 2231.5 of the *Revenue and Taxation Code*, this act does not contain a repealer, as required by that section; therefore, the provisions of this act shall remain in effect unless and until they are amended or repealed by a later enacted act.

APPENDIX I-E-5

Synopsis of

CHAPTER 1659, STATUTES OF 1984

(The "Katz Bill" relating to emergency procedures
for earthquakes and disasters.)

Recognizing that California will experience moderate to severe earthquakes for the foreseeable future, the Legislature passed and the Governor signed this bill to minimize loss of life and disruption during an earthquake and to ensure that school students and staff act instinctively and correctly when an earthquake disaster strikes.

The act amends the *Education Code* to require that, for public or private school buildings with over 50 students or more than one classroom, governing boards of public and private schools, and county superintendents of schools, establish an earthquake emergency system. Such boards and officials are encouraged to work with the California Seismic Safety Commission and the Governor's Office of Emergency Services to draw up a system that includes, as a minimum:

1. A school building disaster plan to maintain the safety and care of students and staff. This plan should be ready for implementation at all times.

2. Periodic drills in a "drop procedure" to train students to take cover in an earthquake under a table or a desk, dropping to his or her knees with the head protected by the arms and the back to the windows. Such drills should be held once a quarter in elementary schools and once a semester in secondary schools.

3. Protective measures to take before, during, and after an earthquake.

4. A program to ensure that students and staff are aware of, and properly trained to use, the earthquake emergency procedure system.

The act also designates public schools as mass care shelters during disasters or emergencies, and calls on governing boards to cooperate with agencies such as the Red Cross in furnishing and maintaining them for such service.

No appropriation is made to reimburse schools and school districts for costs incurred in carrying out these programs, but local agencies or school districts may pursue reimbursement under Chapter 3, Part 4, Division 1 of the *Revenue and Taxation Code.*

APPENDIX II-E-2

LISTINGS OF REGIONAL POISON CENTERS

Los Angeles

Los Angeles County Medical Assn.
Regional Poison Information Center
1925 Wilshire Blvd.
Los Angeles, CA 90057
(213) 484-5151 (Public)
(213) 644-2121 (MDs and hospitals)

Orange

University of California Poison Control Center
Irvine Medical Center
101 City Dr. S., Rte 78
Irvine, CA 92668
(714) 634-5988

Sacramento

UCDMC Regional Poison Control Center
2315 Stockton Blvd.
Sacramento, CA 95817
(916) 453-3692 (Emergency)
(916) 453-3414 (Nonemergency, business information)

San Diego

San Diego Regional Poison Center
University of California
San Diego Medical Center
225 Dickinson St.
San Diego, CA 92103
(619) 294-6000

San Francisco

San Francisco Bay Area Regional Poison Center
San Francisco General Hospital
Room 1-E-86
1001 Potrero Ave.
San Francisco, CA 94110
(415) 476-2845

San Jose

Central-Coast Counties Regional
Poison Control Center
Santa Clara Valley Medical Center
751 S. Bascom Ave.
San Jose, CA 95128
(800) 662-9886
(408) 299-5115

Fresno

Fresno Regional Poison Control Center of Fresno
Community Hospital and Medical Center
Fresno and R Sts.
Fresno, CA 93715
(209) 445-1222

Oakland

Children's Hospital Medical Center
of Northern California
747 52nd St.
Oakland, CA 94609
(415) 428-3248

APPENDIX III-A

STUDENT SAFETY CONTRACT AND STUDENT PAGES

STUDENT SAFETY CONTRACT

I will:

1. Follow all instructions given by the teacher.
2. Protect eyes, face, hands, and body while conducting class activities.
3. Carry out good housekeeping practices.
4. Know where to get help fast (teacher, nurse, principal).
5. Know the location and the use of first-aid and fire-fighting equipment.
6. Conduct myself in a responsible manner at all times in a laboratory situation.

I, _____, have read, studied, and taken my teacher's safety test and agree to abide by the safety regulations and any additional printed instructions provided by the teacher and/or district. I further agree to follow all other written and verbal instructions given in class.

Signature	Date
>	

STUDENT PAGES

SAFETY REGULATIONS FOR SCIENCE STUDENTS

While working in the science laboratory, you will have certain important responsibilities that do not apply to other classrooms. You will be working with materials and apparatus which, if handled carelessly or improperly, have the potential to cause injury or discomfort.

A science laboratory can be a safe place to work if you, the student, are foresighted, alert, and cautious. The following practices will be followed:

1. Report any accident to the teacher immediately, no matter how minor. This includes any burn, scratch, cut, or corrosive liquid on skin or clothing.
2. Perform only those laboratory activities for which instructions and permission have been given by the teacher.
3. Use only materials and equipment authorized by the instructor.
4. Follow written and verbal instructions carefully.
5. Wear appropriate eye protection, as directed by the instructor, whenever working in the laboratory. Safety goggles must be worn during more hazardous experiments involving caustic/corrosive chemicals, heating of liquids, and other activities that may injure the eyes.
6. Prepare for each laboratory activity by reading all instructions before coming to class. Follow all directions implicitly and intelligently. Make note of any modification in procedure given by the instructor.
7. Never carry hot equipment or dangerous chemicals through a group of students.
8. Never taste anything or touch chemicals with the hands unless specifically instructed to do so.
9. Eating or drinking in the laboratory or from laboratory equipment is not permitted.
10. Always test for odor of chemicals by waving your hand above the container and sniffing cautiously from a distance.
11. Never pour reagents back into bottles, exchange stoppers of bottles, or lay stoppers on the table.
12. When diluting acids, always pour acids into water, never the reverse. Combine the liquids slowly while stirring the mixture with a glass rod. Just remember this jingle, "Like ya otter . . . add acid to water."
13. Keep hands away from face, eyes, and body while using solutions, specimens, equipment, or materials in the laboratory. Wash hands thoroughly at the conclusion of the laboratory period.
14. In case of a burn from an acid or alkali, wash the affected area immediately with plenty of running water. If the eye is involved, irrigate it without interruption for at least 15 minutes. Report the incident to your instructor immediately.

15. Check labels and equipment instructions carefully. Be sure correct items are being used in the proper manner.

16. Know the location of the emergency shower, eye and face wash fountain, fire blanket, fire extinguisher, fire alarm box, and exits.

17. Know the proper fire drill procedure.

18. Roll long sleeves up above the wrist. Coats and bulky sweaters should be removed.

19. Keep work areas clean.

20. Confine long hair during a laboratory activity.

21. Light gas burners only as instructed by the teacher.

22. Do not throw used matches into waste paper baskets. A metal container should be provided for their disposal.

23. Dispose of litmus paper, wooden splints, toothpicks, and so on in the same manner as matches.

24. Use a burner with extreme caution. Keep your head and clothing away from the flame and turn it off when not in use.

25. Do not bring any substance into contact with a flame unless specifically instructed to do so.

26. When heating material in a test tube, do not look down into the tube while heating it, or point it in the direction of any student during the process.

27. Place books, purses, and such items in the designated storage area. Take only laboratory manuals and laboratory notebooks into the working area.

28. Student apparel should be appropriate for laboratory work. Long hanging necklaces, bulky jewelry, and excessive and bulky clothing should not be worn in the laboratory.

29. Students are not permitted in laboratory storage rooms or teacher work rooms without the approval of the teacher.

30. Throw all solid waste in designated waste baskets, jars, or other receptacles. Do not discard any solids in the laboratory sinks, especially glass items, such as tubing or cover glasses.

31. Any science project or individually planned experiments must be approved by the teacher.

32. To cut small-diameter glass tubing, use a file or tubing cutter to make a deep scratch. Wrap the tubing in a paper towel before breaking the glass away from you with your thumbs. Fire polish all ends.

33. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine if an object is hot by bringing the back of your hand up close.

34. For some stoppers, one may need to expand the hole using a number 3 cork borer. Lubricate stopper hole and glass tubing with water or glycerin to ease insertion, using towels for hand protection. Carefully twist (never push) glass tubing into stopper holes.

35. Remove all broken glass from work area or floor as soon as possible. Never handle broken glass with bare hands; use counter brush and dustpan. Report broken thermometers to the instructor immediately.

36. When removing an electrical plug from its socket, pull the plug, not the electrical cord.

37. Treat all animals in the science laboratory with respect and consideration for their humane care.

38. Always approach laboratory experiences in a serious and courteous manner.

39. Hazardous or toxic liquids should be disposed of properly. Follow the directions of your instructor.

SCIENCE LABORATORY SAFETY TEST

The following questions were developed to provide teachers with suggested questions from which teacher-developed tests for specific courses may be taken. It is not intended to be comprehensive; it is expected that each teacher will supplement these sample items.

Note that although there are only 40 questions in the sample, the answer sheet which follows the questions has spaces for 100 items. Thus, the answer sheet may be used for a variety of teacher-developed safety tests.

1. If you see something in the classroom or laboratory that is dangerous, tell the teacher--

   a. When you have time
   b. At once
   c. After class
   d. After school

2. Rags or paper towels with flammable liquids or solids on or in them must be put in--

   a. A cardboard box
   b. A metal or crockery container with a lid
   c. A wastebasket
   d. A trash can

3. Any spill on the floor can cause an accident. Always clean it up--

   a. At once
   b. During clean-up time
   c. When you have time
   d. At the end of the period

4. Alcohol, ether, and other volatile materials that can burn easily should never be used near--

   a. Another person
   b. An open flame
   c. A laboratory counter
   d. A work table

5. When you work with laboratory chemicals and Bunsen burners, long hair must be--

   a. Cut off
   b. Held with both hands
   c. Kept out of the way by wearing a band, hat, or hairnet
   d. Combed nicely

6. When you work with laboratory chemicals, equipment, or burners, all loose clothes and loose jewelry must be--

   a. Left on
   b. Removed
   c. Left hanging loose
   d. Made of nonflammable materials

7. If you are hurt (cut, burned, and so on) tell the--

   a. Nurse at once
   b. Teacher at once
   c. Class at once
   d. Doctor after school

8. Whenever you are in the classroom or laboratory, you should wear--

   a. Sandals
   b. Closed shoes
   c. Open-toed shoes
   d. No shoes

9. If you think there is something wrong with a piece of equipment you are using, stop, turn it off, and tell--

   a. The class leader
   b. The teacher
   c. Another student
   d. The custodian

10. If you break a piece of glassware or other equipment, tell the teacher--

    a. The next period
    b. At clean-up time
    c. At once
    d. Never

11. All floors, aisles, and passageways should be kept clear of--

    a. Teachers and students
    b. Laboratory equipment and chemicals
    c. Laboratory equipment only
    d. Chemicals only

12. If you see a fire in an apparatus assembly or a burning liquid such as alcohol, it is best to put it out with--

    a. The fire blanket
    b. Water from the sink
    c. Your coat
    d. The ABC fire extinguisher

13. To put out a fire in a person's hair or clothing, use--

    a. The fire blanket
    b. A handy chemical
    c. The wind from running
    d. The CO_2 fire extinguisher

14. The correct way to move about the classroom or laboratory is to--

    a. Run
    b. Walk
    c. Hurry
    d. Skip

15. Helping to clean up the classroom or laboratory is the job of--

    a. New students
    b. Old students
    c. Each student
    d. The teacher

16. When you use laboratory equipment or chemicals, you should give the procedure all of your--

    a. Interest
    b. Attention
    c. Effort
    d. All of these

17. Chemicals, small parts, glassware, and stirring rods are not to be--

    a. Held in your hand
    b. Put in your mouth
    c. Put on the bench
    d. Taken from boxes

18. To prevent accidents during laboratory activities with chemicals and equipment, you should--

a. Use shortcuts
b. Follow your teacher's directions
c. Hurry ahead of teachers
d. Ask someone else to do the work

19. Playing (as opposed to working) in the laboratory or bothering another person is--

a. Always against the rules
b. All right
c. Not dangerous
d. All right (if you are working)

20. To be able to put out a fire quickly and safely, you should know--

a. How to use extinguishers
b. Where the extinguishers are located
c. Which extinguisher is used for each class of fire
d. All of the above

21. If flammable liquids such as alcohol are spilled, you should first--

a. Let them dry up
b. Use a fire extinguisher
c. Tell the teacher
d. Pour water on them

22. Before you touch an electrical switch, plug, or outlet--

a. Your hands must be dry
b. Ask the custodian
c. Your hands must be clean
d. Ask the nurse

23. Eyeglasses do not provide as much protection as--

a. A face shield
b. Safety glasses
c. Splashproof goggles
d. Any of these (a, b, c)

24. Laboratory aprons, when provided, are for--

a. The protection of you and your clothes
b. Wiping your hands on
c. Others to hang up
d. When you are wearing your best clothes

25. Cabinet drawers and doors that are left open cause a hazard and should be--

a. Walked around
b. Closed by you
c. Left alone
d. Closed by the teacher only

26. In case of fire in the laboratory, notify the teacher at once and then prepare to--

a. Evacuate the building or laboratory
b. Remove flammable materials
c. Open the windows
d. Rapidly clean the laboratory

27. All chemicals should be stored in--

a. Tin cans
b. Dark brown bottles
c. Clear glass bottles
d. Properly labeled containers

28. When preparing dilute solutions of an acid, carefully pour--

a. The acid into water
b. The acid into the container
c. Water into the acid
d. Both liquids at once

29. If acid gets on your skin or clothes, wash at once with--

a. Sulfuric acid
b. Soap
c. Water
d. Oil

30. Spilled acids can be made safe with--

a. Gasoline
b. Alcohol
c. Water
d. Sodium bicarbonate solution

31. Spilled bases can be neutralized and made safe with--

a. Gasoline
b. Alcohol
c. Water
d. Dilute acetic acid solution (vinegar)

32. You must wear approved eye protection while working in the laboratory--

a. To improve your vision
b. Sometimes
c. To avoid myopia
d. Whenever the lab instructions tell you to

33. Disturbing other students while they are working in the laboratory is--

a. Helpful
b. Poor manners
c. Dangerous
d. The quickest way to do a job

34. You should prepare for each laboratory activity by reading all instructions--

a. After school
b. While you are working
c. Before you start to work
d. Next week

35. When measuring small amounts of corrosive or caustic liquids with a pipette, draw the liquid up into the tube by using--

a. Your mouth
b. Your thumb
c. A rubber suction bulb
d. The palm of your hand

36. When heating substances in a test tube, be sure the open end of the tube points toward--

a. Yourself
b. No other person
c. Your partner
d. A classmate

37. After heating glass tubing to bend it, the soonest you may safely handle the tubing is--

a. Within 30 seconds
b. After you are sure it is cool
c. After school
d. The next day

38. To insert glass tubing into a rubber stopper, you should (after fire polishing and cooling)--

    a. Lubricate with water or glycerin
    b. Use a towel for protection
    c. Twist carefully
    d. All of these (a, b, c)

39. To remove an electrical plug from its socket, you should--

    a. Pull the plug itself
    b. Pull on the cord
    c. Pull on the appliance
    d. None of these (a, b, c)

40. On the back of your answer sheet, draw a diagram of your science laboratory or classroom and label the location of the following:

    - Fire blanket
    - Fire extinguisher
    - Exits
    - Safety goggle storage (or dispensing area)
    - Eye wash station
    - Safety shower
    - Closest fire alarm
    - Waste disposal containers (label type of waste each container is suitable for)

ANSWER SHEET FOR SCIENCE LABORATORY SAFETY TESTS

Name	Period	Test No.	Score

Directions: Read each statement in your safety test. Under each question you will find four answers. Choose the one correct answer and fill in the box that represents the answer.

Example: Read question No. 1. The correct answer is "b. at once." Note that the "b" box beside number 1 (below) is darkened. Continue marking all the answers in this manner.

	a	b	c	d		a	b	c	d		a	b	c	d		a	b	c	d
1.	☐	■	☐	☐	26.	☐	☐	☐	☐	51.	☐	☐	☐	☐	76.	☐	☐	☐	☐
2.	☐	☐	☐	☐	27.	☐	☐	☐	☐	52.	☐	☐	☐	☐	77.	☐	☐	☐	☐
3.	☐	☐	☐	☐	28.	☐	☐	☐	☐	53.	☐	☐	☐	☐	78.	☐	☐	☐	☐
4.	☐	☐	☐	☐	29.	☐	☐	☐	☐	54.	☐	☐	☐	☐	79.	☐	☐	☐	☐
5.	☐	☐	☐	☐	30.	☐	☐	☐	☐	55.	☐	☐	☐	☐	80.	☐	☐	☐	☐
6.	☐	☐	☐	☐	31.	☐	☐	☐	☐	56.	☐	☐	☐	☐	81.	☐	☐	☐	☐
7.	☐	☐	☐	☐	32.	☐	☐	☐	☐	57.	☐	☐	☐	☐	82.	☐	☐	☐	☐
8.	☐	☐	☐	☐	33.	☐	☐	☐	☐	58.	☐	☐	☐	☐	83.	☐	☐	☐	☐
9.	☐	☐	☐	☐	34.	☐	☐	☐	☐	59.	☐	☐	☐	☐	84.	☐	☐	☐	☐
10.	☐	☐	☐	☐	35.	☐	☐	☐	☐	60.	☐	☐	☐	☐	85.	☐	☐	☐	☐
11.	☐	☐	☐	☐	36.	☐	☐	☐	☐	61.	☐	☐	☐	☐	86.	☐	☐	☐	☐
12.	☐	☐	☐	☐	37.	☐	☐	☐	☐	62.	☐	☐	☐	☐	87.	☐	☐	☐	☐
13.	☐	☐	☐	☐	38.	☐	☐	☐	☐	63.	☐	☐	☐	☐	88.	☐	☐	☐	☐
14.	☐	☐	☐	☐	39.	☐	☐	☐	☐	64.	☐	☐	☐	☐	89.	☐	☐	☐	☐
15.	☐	☐	☐	☐	40.	☐	☐	☐	☐	65.	☐	☐	☐	☐	90.	☐	☐	☐	☐
16.	☐	☐	☐	☐	41.	☐	☐	☐	☐	66.	☐	☐	☐	☐	91.	☐	☐	☐	☐
17.	☐	☐	☐	☐	42.	☐	☐	☐	☐	67.	☐	☐	☐	☐	92.	☐	☐	☐	☐
18.	☐	☐	☐	☐	43.	☐	☐	☐	☐	68.	☐	☐	☐	☐	93.	☐	☐	☐	☐
19.	☐	☐	☐	☐	44.	☐	☐	☐	☐	69.	☐	☐	☐	☐	94.	☐	☐	☐	☐
20.	☐	☐	☐	☐	45.	☐	☐	☐	☐	70.	☐	☐	☐	☐	95.	☐	☐	☐	☐
21.	☐	☐	☐	☐	46.	☐	☐	☐	☐	71.	☐	☐	☐	☐	96.	☐	☐	☐	☐
22.	☐	☐	☐	☐	47.	☐	☐	☐	☐	72.	☐	☐	☐	☐	97.	☐	☐	☐	☐
23.	☐	☐	☐	☐	48.	☐	☐	☐	☐	73.	☐	☐	☐	☐	98.	☐	☐	☐	☐
24.	☐	☐	☐	☐	49.	☐	☐	☐	☐	74.	☐	☐	☐	☐	99.	☐	☐	☐	☐
25.	☐	☐	☐	☐	50.	☐	☐	☐	☐	75.	☐	☐	☐	☐	100.	☐	☐	☐	☐

The space below is for the laboratory or classroom diagram.

THIS IS TO CERTIFY that I have received safety instructions in _____. My teacher has demonstrated to me how to use materials and equipment correctly and safely. I promise to observe all safety precautions and if ever in doubt regarding any procedure, I will get the necessary information from my teacher.

Signature	Date
>	

ANSWER SHEET FOR SCIENCE LABORATORY SAFETY TESTS

Name	Period	Test No.	Score
Key			

Directions: Read each statement in your safety test. Under each question you will find four answers. Choose the one correct answer and fill in the box that represents the answer.

Example: Read question No. 1. The correct answer is "b. at once." Note that the "b" box beside number 1 (below) is darkened. Continue marking all the answers in this manner.

	a	b	c	d
1.	☐	■	☐	☐
2.	☐	■	☐	☐
3.	■	☐	☐	☐
4.	☐	■	☐	☐
5.	☐	☐	■	☐
6.	☐	■	☐	☐
7.	☐	■	☐	☐
8.	☐	■	☐	☐
9.	☐	■	☐	☐
10.	☐	☐	■	☐
11.	☐	■	☐	☐
12.	☐	☐	☐	■
13.	■	☐	☐	☐
14.	☐	■	☐	☐
15.	☐	☐	■	☐
16.	☐	☐	☐	■
17.	☐	■	☐	☐
18.	☐	■	☐	☐
19.	■	☐	☐	☐
20.	☐	☐	☐	■
21.	☐	☐	■	☐
22.	■	☐	☐	☐
23.	☐	☐	☐	■
24.	■	☐	☐	☐
25.	☐	■	☐	☐

	a	b	c	d
26.	■	☐	☐	☐
27.	☐	☐	☐	■
28.	■	☐	☐	☐
29.	☐	☐	■	☐
30.	☐	☐	☐	■
31.	☐	☐	☐	■
32.	☐	☐	☐	■
33.	☐	☐	■	☐
34.	☐	☐	■	☐
35.	☐	☐	■	☐
36.	☐	■	☐	☐
37.	☐	■	☐	☐
38.	☐	☐	☐	■
39.	■	☐	☐	☐
40.	☐	☐	☐	☐
41.	☐	☐	☐	☐
42.	☐	☐	☐	☐
43.	☐	☐	☐	☐
44.	☐	☐	☐	☐
45.	☐	☐	☐	☐
46.	☐	☐	☐	☐
47.	☐	☐	☐	☐
48.	☐	☐	☐	☐
49.	☐	☐	☐	☐
50.	☐	☐	☐	☐

	a	b	c	d
51.	☐	☐	☐	☐
52.	☐	☐	☐	☐
53.	☐	☐	☐	☐
54.	☐	☐	☐	☐
55.	☐	☐	☐	☐
56.	☐	☐	☐	☐
57.	☐	☐	☐	☐
58.	☐	☐	☐	☐
59.	☐	☐	☐	☐
60.	☐	☐	☐	☐
61.	☐	☐	☐	☐
62.	☐	☐	☐	☐
63.	☐	☐	☐	☐
64.	☐	☐	☐	☐
65.	☐	☐	☐	☐
66.	☐	☐	☐	☐
67.	☐	☐	☐	☐
68.	☐	☐	☐	☐
69.	☐	☐	☐	☐
70.	☐	☐	☐	☐
71.	☐	☐	☐	☐
72.	☐	☐	☐	☐
73.	☐	☐	☐	☐
74.	☐	☐	☐	☐
75.	☐	☐	☐	☐

	a	b	c	d
76.	☐	☐	☐	☐
77.	☐	☐	☐	☐
78.	☐	☐	☐	☐
79.	☐	☐	☐	☐
80.	☐	☐	☐	☐
81.	☐	☐	☐	☐
82.	☐	☐	☐	☐
83.	☐	☐	☐	☐
84.	☐	☐	☐	☐
85.	☐	☐	☐	☐
86.	☐	☐	☐	☐
87.	☐	☐	☐	☐
88.	☐	☐	☐	☐
89.	☐	☐	☐	☐
90.	☐	☐	☐	☐
91.	☐	☐	☐	☐
92.	☐	☐	☐	☐
93.	☐	☐	☐	☐
94.	☐	☐	☐	☐
95.	☐	☐	☐	☐
96.	☐	☐	☐	☐
97.	☐	☐	☐	☐
98.	☐	☐	☐	☐
99.	☐	☐	☐	☐
100.	☐	☐	☐	☐

APPENDIX III-A-2

SAFETY CHECKLIST FOR SCIENCE INSTRUCTION, PREPARATION, AND STORAGE AREAS

Science teachers should periodically check their instructional areas to determine whether unsafe conditions exist.

Teachers having concerns about safety conditions related to facilities, equipment, supplies, curriculum, classroom occupant load, and so on should notify their department chairperson and site administrator in writing immediately for assistance in alleviating the condition.

The following checklist may be used to:

- Determine whether or not a safe environment exists.
- Indicate possible areas of concern and danger.
- Act as a monitoring device for periodic safety checks.
- Act as a permanent record of an ongoing safety program.

1. General good housekeeping prevails and aisles are clear of materials and apparatus. _____
2. Adequate storage space is provided for chemicals, materials, and apparatus. _____
3. The classroom/laboratory has no blind spots where students cannot be supervised by the teacher from anywhere in the classroom. _____
4. Open shelves are equipped with lips or restraining wires to prevent spilling of chemicals or broken glassware during an explosion or earthquake. _____
5. The light level is adequate (about 75 to 100 foot-candles at work surfaces). _____
6. Separate fireproof waste containers are provided for spent matches, filter paper, flammable chemicals, and so on. _____
7. Separate waste containers are provided for broken glass, nonflammable used chemicals, and so on. _____
8. A fire extinguisher is kept in working condition at all times in a conspicuous and accessible place. _____
9. An approved fire blanket is kept in a conspicuous and accessible place. _____
10. Flammable fluids and materials stored in the classroom are kept in fireproof containers (not glass) and in quantities sufficient for only one day's supply. _____
11. An approved fire-retardant storage cabinet separate from the classroom is used to store larger quantities of flammable, corrosive, and other dangerous chemicals. _____

12. Flammable liquids are not kept in refrigerators, unless it is certified as explosion proof. _____

13. Food is not kept in refrigerators used for storing science supplies. _____

14. To avoid contact with possible flooding or other spilled chemicals, store large storage bottles of strong acids and bases plus other dangerous chemicals on the lowest cabinet shelves but not on the floor. _____

15. Ethers are periodically disposed of if the presence of peroxides is suspected. (See General Safety Procedures for Chemistry Laboratories, page 68 of this handbook.) _____

16. Sodium is stored under kerosene or oil. _____

17. Incompatible chemicals are not stored adjacent to one another.(See page 39 for a list of compatibility categories for chemicals found in high school laboratories.) _____

18. All chemicals are dated on receipt, and a current inventory is maintained. _____

19. Quantities of hazardous chemicals kept on hand are limited to the amounts needed during one school year. _____

20. Proper labels and signs are kept in place on all chemicals and on the storage area. _____

21. Neutralizing reagents are located conveniently in the laboratory for treatment of spills. _____

22. Chemical containers are inspected periodically for leakage or deterioration (such as sediments and discoloration), and approved disposal procedures are followed as necessary. _____

23. Any cylinder gas is stored according to the required safety codes, e.g., chained or strapped in a cart or to the wall. _____

24. Splash-proof safety goggles, face shields, aprons, safety shields, and so on are available to protect students when hazardous conditions exist. _____

25. Eye wash fountains and safety showers are easily accessible, identified, and flushed weekly to remove rust and scale. _____

26. Fume hoods are clean, uncluttered, and tested periodically for adequate air flow. _____

27. Electrical outlets and extension cords are kept in a safe working condition. _____

28. All electrical equipment should be three-wire grounded except for double-insulated tools or equipment which has no exposed metallic parts that could become energized. _____

29. Electrical equipment such as the refrigerator and aquarium aerators are connected directly to wall outlets and not serviced through an extension cord. _____

30. Gas outlets and burners are maintained in safe working condition. _____

31. The location of the master gas shut-off valve is known and readily accessible. _____

32. Plumbing fixtures are in correct operating condition. Faucets must be equipped with vacuum breakers to prevent backflow. _____

33. Sink drains are inspected periodically for corrosion and kept free from solid wastes. _____

34. Fire drill regulations are posted and familiar to all students. _____

35. The school district's emergency procedures are prominently posted. _____

36. An adequate first-aid kit, including the Red Cross *Standard First Aid and Personal Safety Manual* or appropriate alternate information, is provided. (See First Aid Safety section of this publication.) _____

37. The teacher is familiar with first aid and safety measures pertinent to science instruction and as presented in this publication. _____

38. The *California Science Safety Handbook* is readily accessible. _____

39. Ether on hand was purchased no longer than one year ago. (Refer to page 68 of this publication.) _____

APPENDIX III-A-3

SAFETY/ENERGY SAVING ITEMS TO DO BEFORE END OF YEAR

A. Inventory all chemicals. Remove all outdated, deteriorated, potentially dangerous, and/or not-likely-to-be-used substances. Pack them in separate boxes by compatibility category, clearly marked "chemicals for disposal." Include a list of contents in each box. Call appropriate district office or waste disposal agency for pickup, identifying the *exact location* of the materials to be picked up.

B. Dispose of older than one year or partially used containers of diethyl ether using the *procedure outlined* on page 68 in this handbook. Any ether may form peroxides as described in the handbook. Exception: recently received, unopened containers of ethers that were dated on receipt and can be verified as less than one-year old by their time of use in fall laboratory activities may be retained and locked in district standard flammable liquid cabinets over the summer break. Refer to Appendix III-A-2, Safety Checklist, items 16, 19, and 20 on page 132 in this handbook.

   Recommendation: Order only supplies of ether necessary for the current school year.

C. Be certain all gas cylinders in high school laboratories are capped and properly secured for the summer.

D. Clean out, defrost, and leave unplugged all refrigerators during the summer break. Block door open to allow air circulation and prevent mildew growth. This is recommended for safety and energy conservation.

E. Additional energy-saving actions:

   - Arrange for shutoff of any water heaters in the science department.

   - Unplug all electrical items, such as isolated wall clocks, timers, personal table clocks/radios, hotplates, aquarium pumps, computers, terminals, microscope lights, and oscilloscopes (any electrically powered science instructional item).

APPENDIX III-B-3

_____ SCHOOL DISTRICT
SAMPLE
BIOLOGICAL SCIENCE LABORATORY REGULATIONS

The following samples of the biological and physical science laboratory regulations and the preceding more general Student Safety Contract, the Safety Regulations for Science Students, and the Science Laboratory Safety Test are provided as models to enable teachers to make students and parents aware of potential hazards and to keep a record of acknowledgment of this awareness through the return of the tear-off, signed forms and completed safety tests. For non-English-proficient and limited-English-proficient students, oral instructions and oral tests may be used.

General

Require that an instructor be present during the performance of all laboratory work.

Perform only those experiments specifically designed or approved by the instructor. Unauthorized experimentation will not be permitted. Follow directions exactly.

Perform all experiments carefully and in such a manner as to provide for the safety of all persons.

Report any accident to the instructor at once.

Equipment and Instruments

Be sure all containers are clean before using.

Never force glass tubing or a thermometer into or out of stoppers. Always lubricate stoppers and tubing with water or glycerin first before inserting. Protect your hand from possible broken glass when inserting a stopper or tubing by wrapping a paper towel or cloth near the end of the glass where the stopper or tubing is to be inserted. Use a twisting motion when inserting into a stopper.

Before cutting, heating, or bending glass tubing, get proper instructions from the instructor.

Use proper glassware that resists breaking when performing experiments which require the heating of the glass.

Before heating any apparatus, be sure all the outlets of the apparatus are open.

Never point the mouth of a test tube toward your face or toward your neighbor while you are heating the tube. Always slant a test tube when heating it and apply heat along the test tube and not just at the very bottom.

When heating volatile materials, use a water bath; that is, in or over heated water, never directly over open flames. Extinguish all open flames. A hotplate should be used to heat the water.

Do not reach over an open flame. Turn Bunsen burner off when it is not in use.

Pass scissors, scalpels, dissecting needles, and other sharp-edged instruments with their handles extended when handing them to other students.

Scalpels are recommended for dissection. If razor blades are provided, use only single-edged blades.

Wash all sharp-edged instruments separately from other equipment.

To avoid injury, keep instruments in their designated places when not in use.

Chemicals

Read labels carefully before taking materials from containers.

Never taste or drink anything in the laboratory unless specifically directed by the instructor to do so. If you taste or swallow any chemical accidentally, report the fact at once to the instructor.

In case of a burn from an acid or alkali, wash the affected area immediately with plenty of cool running water. Then report to the instructor at once.

Never add water to an acid (especially sulfuric acid). Instead, add acid slowly to water and stir constantly with a glass stirring rod.

When noting the odor of any liquid, do not put your face directly over the container. Rather, fan a little of the vapor toward you by sweeping your hand above the top of the container.

Dispose of all waste chemicals as directed by the instructor. Clean glassware as directed. Never return unused chemicals to supply containers.

Wipe up immediately any relatively harmless substances spilled on the floor or desktops. Tell the instructor about spills of harmful substances.

Use great care when working with ether or other volatile liquids. Windows and doors should be opened for greatest possible ventilation. Be sure that caps or lids of containers used for chemicals are securely closed.

Never heat alcohol, ether, or other volatile or flammable substance over an open flame.

When working with chemicals that could injure your eyes, you must wear eye protection.

Never make explosive compounds or mixtures.

Plants and Animals

Never handle animals in the laboratory unless directed to do so by the instructor.

Never insert your fingers or objects through the wire mesh of animal cages to poke or pet animals.

Notify the instructor at once if an animal bites you. Never bring poisonous plants or animals to school. When dissecting preserved specimens, you must wear eye protection.

Radioisotopes

Never use radioisotopes unless directed to do so by the instructor. Perform experiments using radioisotopes only under the direct supervision of the instructor.

Avoid inhalation or ingestion of radioactive materials.

Never mouth-pipette radioactive solutions. Use a pipette control device, rubber bulb, or medicine dropper.

Never use cosmetics, eat, or drink in a room where radioactive materials are being used.

Avoid contamination of hands with radioactive materials. Wash hands with soap for several minutes after working with radioactive materials.

Dispose of radioactive materials used in laboratory experiments as directed by the instructor.

Bacteria and Fungi

Never open petri dishes containing bacterial growth unless directed to do so by the instructor.

Dispose of all discarded bacterial and fungus cultures by sterilization as directed by the instructor.

(Detach and return signed forms to science instructor.)

Student's Statement

THIS IS TO CERTIFY that I have read pages 1 through 3 of the "Biological Science Laboratory Regulations" which are prescribed by the _____ School District and hereby agree to abide by them at all times while in the laboratory.

Signature of student >	Date

Parent's or Guardian's Statement

I have read pages 1 through 3 of the "Biological Science Laboratory Regulations" and give my consent for _____ to engage in laboratory activities using a variety of science equipment and materials including those described. I hereby pledge my cooperation in urging that my daughter/son observe the safety regulations which are prescribed by the _____ School District.

Signature of parent or guardian >	Date

APPENDIX III-B-4

_____ SCHOOL DISTRICT

SAMPLE

PHYSICAL SCIENCE LABORATORY REGULATIONS

The following regulations have been compiled for the safety of students performing experimental work in physical science classes. Strict observance of the regulations is mandatory. All students in the _____ _____ School District are to follow these regulations rather than any conflicting instructions in textbooks or laboratory manuals.

Students and parents are to read these regulations, sign the form, and return it to the instructor. This procedure must be completed before a student can begin any laboratory activity. The student should keep a copy of the regulations in his or her notebook for future reference.

General

Remember that an instructor is required to be present during the performance of all laboratory work. The phrase *under direct supervision of the instructor* means in the presence of and under direct observation of the instructor during the entire operation of an experiment.

Follow directions exactly.

Perform all experiments carefully and in such manner as to ensure the safety of all persons.

Perform ONLY those experiments specifically designated or approved by the instructor. Unauthorized experimentation will not be tolerated.

ALWAYS wear appropriate eye protection, as directed by the instructor, when working in the laboratory.

ALWAYS use small quantities of materials, unless specifically directed by the instructor to use larger amounts.

Protect your clothing from chemicals. Clothes may be protected by a laboratory apron.

Report ANY accident to the instructor at once.

Handling Equipment

Be sure all containers, such as test tubes, beakers, and flasks, are clean before using.

Never leave material in containers from a previous experiment as they may cause errors in new experiments or may cause a violent reaction or explosion.

Never force glass tubing into or out of stoppers. Use appropriate lubrication, such as water or glycerin, on stoppers and tubing.

Protect your hand from possible broken glass when inserting a stopper or tubing by wrapping a paper towel or cloth near the end of the glass where the stopper or the tubing is to be inserted.

Before cutting, heating, or using glass tubing, get proper instructions from the instructor.

Before heating any apparatus, be sure all the tubing and outlets of the apparatus are open.

Never point the mouth of a test tube toward your face or toward your neighbor while you are heating the tube.

Always slant a test tube when heating it and apply heat along the test tube, not just at the very bottom.

Never drink out of laboratory glassware.

Do not pass your hand or arm over a lighted burner.

Always turn off burners when not in use.

Handling Chemicals

Read labels carefully before taking materials from containers.

Never taste or drink anything in the laboratory unless specifically directed by the instructor to do so. Poisonous substances are not always so labeled. If you taste or swallow any chemical accidentally, report the fact, at once, to the instructor.

In case of a burn from an acid or alkali, wash the affected area immediately with plenty of running water. Then report to the instructor at once.

Never add water to an acid (especially sulfuric acid). Instead, add acid slowly to the water and stir constantly.

When noting the odor of any liquid, do not put your face directly over the container. Rather, fan a little of the vapor toward you by sweeping your hand above the top of the container.

Dispose of all waste chemicals as directed by the instructor. Never return unused chemicals to containers.

Wipe up immediately any relatively harmless substances spilled on the floor or desktops. Tell the instructor about spills of harmful substances.

Use great care when working with ether or other volatile liquids. Windows and doors should be opened for greatest possible ventilation. Be sure that caps or lids of containers used for chemicals are securely closed.

Never heat or take near a flame or spark alcohol, ether, gasoline, or other volatile or flammable substances.

When working with chemicals that could injure your eyes, you must wear eye protection.

Never make explosive compounds or mixtures. Potassium chlorate must be used ONLY IN DEMONSTRATIONS BY THE INSTRUCTOR.

The preparation of a supersaturated solution of sodium thiosulphate (hypo) must be done ONLY AS A DEMONSTRATION BY THE INSTRUCTOR.

Explosive gases such as carbon monoxide, hydrogen, and acetylene must be generated ONLY UNDER THE DIRECT SUPERVISION OF THE INSTRUCTOR.

Poisonous gases such as chlorine, hydrogen sulfide, carbon monoxide, and nitrogen peroxide must be generated in a fume hood equipped with suction draft and ONLY UNDER THE DIRECT SUPERVISION OF THE INSTRUCTOR.

Never use concentrated acids unless specifically directed to do so by the instructor.

Never handle dangerous chemicals such as metallic sodium, potassium, or red or white phosphorus. These must be used ONLY IN DEMONSTRATION BY THE INSTRUCTOR.

(Detach and return signed forms to science instructor.)

Student's Statement

THIS IS TO CERTIFY that I have read pages 1 through 3 of the "Physical Science Laboratory Regulations" which are prescribed by the _____ School District and hereby agree to abide by them at all times while in the laboratory.

Signature of student >	Date

Parent's or Guardian's Statement

I have read pages 1 through 3 of the "Physical Science Laboratory Regulations" and give my consent for _____ to engage in laboratory activities using a variety of science equipment and materials including those described. I hereby pledge my cooperation in urging that my daughter/son observe the safety regulations which are prescribed by the _____ School District.

Signature of parent or guardian >	Date

APPENDIX III-C

CHEMISTRY LABORATORY LEGAL SAFETY CHECKLIST

The checklist below represents some of the key concerns that schools, districts, and individuals should review, address, and implement in an effort to reduce their potential liability in the laboratory setting:

1. Inspect the classroom daily for any irregularities or dangerous situations including, but not limited to, faulty equipment, proper ventilation, and safety supplies. _____

2. Provide proper instruction and review regarding all aspects and safety procedures, including:

   a. Proper use of material and equipment _____

   b. Potential dangers and appropriate action _____

   c. Disposal and clean-up procedures _____

3. Provide written materials relating to safety precautions on a regular basis as follow-up and reinforcement to the regular teaching and instructional programs. _____

4. Inform students and parents both verbally and in written form as to the consequences of inappropriate behavior, horseplay, and unsafe use of equipment and materials. A written waiver slip signed by both parents and students which warns them of the *specific* dangers for unsafe use of materials or equipment is recommended. _____

5. Document and maintain files regarding the types of instruction and the dates when safety-related instructions were demonstrated, conducted, or tested _____

6. District and school-adopted guidelines should be implemented, maintained, and reviewed on a regular basis. _____

7. Potential dangers (safety hazards, defective equipment, or unsafe conditions) should be reported immediately to the district-designated safety officer. Students should not be allowed to work under dangerous situations (as defined in district-adopted guides). Instructors must not allow students to continue working in a dangerous situation. _____

8. Districts have a duty to provide qualified instructors who are able to show the proper use and care and maintenance of safety equipment. Documentation of staff training (group or individual) should be maintained at both school and district sites. Document and record the types of safety materials, in-service training, and instruction classes that staff members were sent to or attended. _____

9. Districts and instructors must have an emergency plan of action that includes the following:

   a. Safety procedure plan which defines the who, what, when, and where involved, and how emergency help will be handled and managed. _____

b. Location and procedures that will be utilized by medical specialists, appropriate for the specific injury. _____

10. Signed parental consent forms should be on file that provide full disclosure (specific instruction listing potential dangers). _____

11. Safety recordkeeping should include:

a. Scripts _____

b. Videotape/films _____

c. Lessons _____

d. Test for knowledge and training _____

e. Accidents and procedures to remediate (Include dates and times of meetings.) _____

f. Equipment inspection _____

g. Emergency care documents (medical release forms) _____

h. Training (e.g., CPR, OSHA, guides and guidelines) for both students and staff which indicates a knowledge of *current change* and procedures _____

i. First-aid training and kit maintenance _____

j. Procedure for contacting the following community resources/information should be established and made available to every instructor:

(1) Fire department _____

(2) Ambulance _____

(3) Hospital _____

(4) Doctor/dentist _____

(5) Parents: consent notification _____

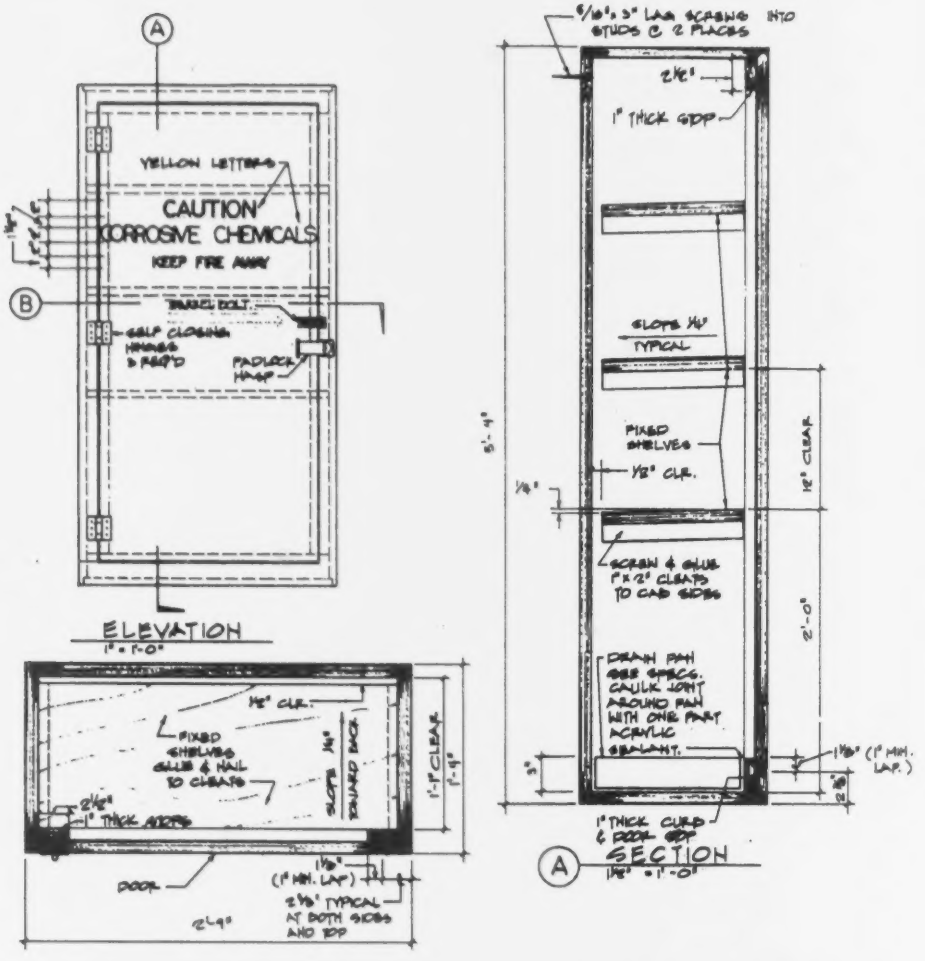
(6) Student medical release form _____

(7) Student medical records (e.g., special medical problems) _____

By following the suggestions listed above, instructors, districts, and students can improve their ability to safely and effectively conduct laboratory activities. Failure to implement the procedures increases the relative degree for district and individual liabilities.

APPENDIX III-C-2b

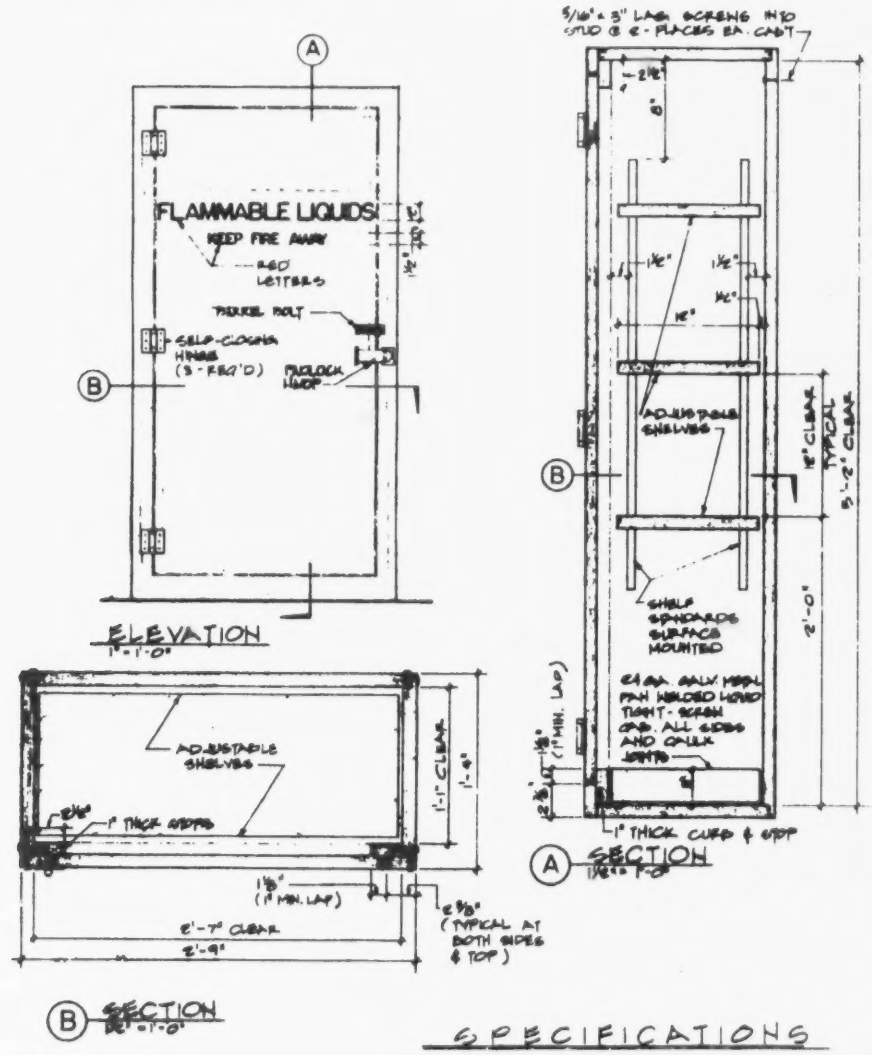
CORROSIVE CHEMICALS STORAGE CABINET BLUEPRINT



SPECIFICATIONS

1. CABINET MATERIAL:
   a. SHALL BE 1" THICK "A-D" EXT. GRADE PLYWOOD WITH EXT. GLUE.
   b. SHELVES & CLEATS SHALL BE 1" OR 3/4" THICK PLYWOOD AS SPECIFIED ABOVE OR 3/4" GOLD DOUGLAS FIR WOOD STOCK.
2. CONSTRUCTION:
   ALL JOINTS SHALL BE RABBETED, GLUED AND SCREWED EA. WAY WITH # 8 x 2" F.H. WOOD SCREWS @ 6" O.C.
3. HARDWARE:
   a. HINGES: HEAVY DUTY, SELF CLOSING; STANLEY # 154, OR BOMMER 8100, OR EQUAL.
   b. BARREL BOLT: 4" LONG, STANLEY "OP 1015 U32C" OR EQUAL.
   c. SAFETY HASP & STAPLE: 4½" x 1½", STANLEY SC 93 OR EQ.; NON CORROSIVE METAL.
4. PAINTING:
   PAINT INTERIOR & EXTERIOR OF CABINET WITH AN INTUMESCENT TYPE FIRE RETARDANT PAINT, SHERWIN-WILLIAMS "KIMGUARD" #K16WE, OR "PLANCRT" (SOLVENT TYPE) BY PLANCRT CHEMICAL CO., OR EQUAL MEETING FEDERAL SPEC. TT-P-0065D; APPLY 2 COATS OF WHITE COLOR.
5. DRAIN PAN:
   CORROSION RESISTANT MATERIAL. PAN TO BE LIQUID TIGHT. FASTEN TO CABINET @ ALL SIDES WITH S.S. R.H. WD. SCREWS.

FLAMMABLE LIQUIDS STORAGE CABINET BLUEPRINT



SPECIFICATIONS

1. CABINET MATERIAL:
   a. ALL MATERIAL SHALL BE 1" THICK "A-B" EXTERIOR GRADE PLYWOOD WITH EXTERIOR GLUE.
   b. SHELVES SHALL BE 1" OR ¾" THICK PLYWOOD AS SPECIFIED ABOVE OR ⅝" SOLID D.F. STOCK.
2. CONSTRUCTION:
   ALL JOINTS SHALL BE RABBETED, GLUED & SCREWED E.W. WITH #8 x 2" F.H. WOOD SCREWS @ 6" O.C.
3. HARDWARE:
   a. HINGES: HEAVY DUTY, SELF CLOSING, STANLEY # 1154 OR BOMMER 2100, OR EQUAL
   b. BARREL BOLT: 4" LONG STANLEY #DP 1078 US 26, OR EQUAL.
   c. SHELF STANDARDS: 36" LONG, K.V. # 255 OR GRANT 125
   d. SHELF CLIPS: K.V. # 256, OR GRANT # 72
   e. CABINET LOCK: SAFETY HASP & STAPLE. 4½" x 1½" STANLEY 2C4193 OR EQ., NON CORRODIVE METAL.
4. PAINTING:
   PAINT INTERIOR & EXTERIOR OF THE CABINET WITH AN INTUMESCENT TYPE FIRE-RETARDANT PAINT, 2-COATS, SHERWIN WILLIAMS "K-MACHARD" # K 16 W 8, OR "FLAMORT" (SOLVENT TYPE) BY FLAMORT CHEMICAL CO., COLOR WHITE (FEDERAL SPEC # TT-P-00206)

APPENDIX III-C-5a

EXTREMELY HAZARDOUS WASTE PERMIT
REGIONAL OFFICE LISTINGS

Permitting, Surveillance, and Enforcement of Local Treatment, Storage, and Disposal Facilities

Local Superfund and Other Site Mitigation Activities

James Allen, Chief
Northern California Section
Toxic Substances Control Division
4250 Power Inn Road
Sacramento, CA 95826
916-739-3145

Fresno District Office
Northern California Section
Toxic Substances Control Division
5545 East Shields Avenue
Fresno, CA 93727
209-445-5938
(*Surveillance and Enforcement Only*)

Dwight Hoenig, Chief
North Coast California Section
Toxic Substances Control Division
2151 Berkeley Way, Annex 7
Berkeley, CA 94704
415-540-2043

Angelo Bellomo, Chief
Southern California Section
Toxic Substances Control Division
107 South Broadway, Room 7011
Los Angeles, CA 90012
213-620-2380

APPENDIX III-C-5b

CALIFORNIA DEPARTMENT OF HEALTH SERVICES
Hazardous Waste Management Branch

APPLICATION FOR CALIFORNIA EXTREMELY HAZARDOUS WASTE DISPOSAL PERMIT*

WASTE PRODUCER: PLEASE CHECK APPLICABLE PERMIT REQUEST:

☐ New Permit _____

☐ Renewal Permit (Previous Permit No. _____ Date _____)

☐ Amendment (Current Permit No. _____ Date _____)

☐ Verbal Permit (No. _____ Date _____)
(If given verbal emergency permit by telephone)

For Office Use Only
Permit No.
Date Handled

Please type or print clearly. Provide all information requested, since omission will result in delay or denial of permit. Allow 15 days process time from day of permit receipt.

WASTE PRODUCER:

Name of Firm: SAN TOMÁS HIGH SCHOOL DISTRICT
Telephone No. (Include Area Code): (000) 555-1212
Street and No. (or P.O. Box): 123 MAIN ST.
County:
City: ANYTOWN
State: CA
Zip Code: 95555
Pick up Address (If different than above): FARMTOWN HIGH SCHOOL
1234 OAK ST., CA 9543[illegible]
Applicant (Typed): JOHN DOE
Title: DIRECTOR OF MAINTENANCE
Signature of Applicant: John Doe
Date:

SAMPLE

PROPOSED HAULER:

Name of Firm: INTERNATIONAL TECHNOLOGY CORPORATION
Street and No. (or P.O. Box): 4585 PACHECO BOULEVARD
City: MARTINEZ
State: CA
Zip Code: 94553
Hauler No.: 000
EPA ID NUMBER: 000 000 000

PROPOSED DISPOSAL (OR OTHER) FACILITY:

Name of Firm: CHEMICAL WASTE MANAGEMENT
Street and No. (or P.O. Box): 35251 OLD SKY LINE ROAD / PO BOX 471
City: KETTLEMAN CITY
State: CA
Zip Code: 93239

HAZARDOUS WASTE MANAGEMENT BRANCH OFFICES

4250 Power Inn Rd. Sacramento, CA 95826 (916) 739-3145	2151 Berkeley Way, Rm. 119 Berkeley, CA 94704 (415) 540-2043	5545 E. Shields Ave. Fresno, CA 93727 (209) 445-5938	107 S. Broadway, Rm. 7011 Los Angeles, CA 90012 (213) 620-2380

*Required for handling or disposal of extremely hazardous wastes. (Section 66570, Title 22, CAC.)

CALIFORNIA DEPARTMENT OF HEALTH SERVICES
Hazardous Waste Management Branch

APPLICATION FOR CALIFORNIA EXTREMELY HAZARDOUS WASTE PERMIT

Company _____ City _____ Date _____

Description of Waste: (Including Composition with Upper and Lower Concentration of Hazardous Components)	Waste Component(s)	Upper	Lower	%	ppm	QUANTITY On One Time Basis: Number:	Units:
WASTE 1	YELLOW PHOSPHORUS	100	80	☑	☐	1	.2516
				☐	☐		
				☐	☐		
				☐	☐		
				☐	☐		
				☐	☐		

On Year's Permit:
Per Disposal (est'd) _____
Per Year (est'd) _____

Description of Packaging, Containerization and Transport: ☐ Drums ☐ Cartons ☐ Bottles ☐ Tank Truck
☑ Other LAB PACKS

PROPOSED METHOD OF DISPOSAL: ☑ Burial ☐ Ponding ☐ [illegible] ☐ Incineration ☐ Other (Specify): _____
☐ Treatment (Specify): _____
☐ Recycling (Specify method of reuse): _____

sample

Packaging, containerization, and transport of the material shall be in accordance with Title 49, Code of Federal Regulations for hazardous materials, and with regulations of the California Highway Patrol, Title 13, California Administrative Code, for intrastate transport of hazardous materials and, for PCB-containing wastes, in accordance with U.S.E.P.A. regulations set forth in Title 40 CFR Part 761.

☐ Check if additional wastes are described on page 3 of 3.

PERMIT TO BE USED FOR: *(Length of Time)*

☑ On a one time basis

☐ For a period of one year from date of issue

PERMIT RENEWALS: *Application for renewal of a one-year blanket permit, using this form, must be received at least 15 days prior to expiration date to keep permit in effect. No reminder of the need to renew will be sent.*

For renewal, send a copy of existing permit with cover letter requesting any additional amendments.

**Storage means holding at an off-site facility for greater than 72 hours. (Section 66192, Title 22, CAC)

CALIFORNIA DEPARTMENT OF HEALTH SERVICES
Hazardous Waste Management Branch

Page 3 of 3

APPLICATION FOR CALIFORNIA EXTREMELY HAZARDOUS WASTE PERMIT

Company _____ City _____ Date _____

ADDITIONAL WASTES

WASTE 2

Description of Waste: (Including Composition with Upper and Lower Concentration of Hazardous Components)

Waste Component(s)	Upper	Lower	%	ppm	QUANTITY On One Time Basis: Number:	Units:
POTASSIUM METAL STICKS	100	75	☑	☐	1	.2516

On Year's Permit:
Per Disposal (est'd) _____
Per Year (est'd) _____

Description of Packaging, Containerization and Transport: ☑ Drums ☐ Cartons ☐ Bottles ☐ Tank Truck ☑ Other LAB PACKS

PROPOSED METHOD OF DISPOSAL: ☑ Burial ☐ Ponding ☐ Storage** ☐ Incineration ☐ Other (Specify): _____
☐ Treatment (Specify): _____
☐ Recycling (Specify method of reuse): _____

WASTE 3

Description of Waste: (Including Composition with Upper and Lower Concentration of Hazardous Components)

Waste Component(s)	Upper	Lower	%	ppm	QUANTITY On One Time Basis: Number:	Units:
SODIUM METAL INGOT	60	10	☑	☐	1	1 GAL.

On Year's Permit:
Per Disposal (est'd) _____
Per Year (est'd) _____

Description of Packaging, Containerization and Transport: ☑ Drums ☐ Cartons ☐ Bottles ☐ Tank Truck ☑ Other LAB PACKS

PROPOSED METHOD OF DISPOSAL: ☑ Burial ☐ Ponding ☐ Storage** ☐ Incineration ☐ Other (Specify): _____
☐ Treatment (Specify): _____
☐ Recycling (Specify method of reuse): _____

WASTE 4

Description of Waste: (Including Composition with Upper and Lower Concentration of Hazardous Components)

Waste Component(s)	Upper	Lower	%	ppm	QUANTITY On One Time Basis: Number:	Units:
HYDROFLUORIC ACID	100	70	☑	☐	2	1 PT.

On Year's Permit:
Per Disposal (est'd) _____
Per Year (est'd) _____

Description of Packaging, Containerization and Transport: ☑ Drums ☐ Cartons ☐ Bottles ☐ Tank Truck ☑ Other LAB PACKS

PROPOSED METHOD OF DISPOSAL: ☑ Burial ☐ Ponding ☐ Storage** ☐ Incineration ☐ Other (Specify): _____
☐ Treatment (Specify): _____
☐ Recycling (Specify method of reuse): _____

Sample

APPENDIX III-C-5c

MANIFEST REORDER REQUEST

MANIFEST REORDER REQUEST

INSTRUCTIONS:

Please provide the information requested below. Check the proper facility type. If transporter facility is checked, enter the hauler registration number. Allow a maximum of four (4) weeks for delivery. Return the completed form to the Department of Health Services, Toxic Substances Control Division, 714/744 P Street, Sacramento, CA 95814. Attn: Manifest Reorder Unit.

Facility EPA ID Number	Contact Name

Company Name

Street Address	City	State	Zip Code

PO Box Number	City	State	Zip Code

Telephone Number Area Code	Number	Extension

FACILITY TYPE

☐ Generator ☐ TSDF ☐ Transfer Station

☐ Storage Facility ☐ Transporter / Hauler Registration Number _____

Number of Manifests Ordered

FOR OFFICE USE ONLY

Manifests Sent 1/83 to Date	Manifests Returned 1/83 to Date	Manifest Balance at Facility

INFORMATION ON LAST FIVE (5) ORDERS

Date	Number Ordered	Number Continuation Sheets	Manifest ID Number	Date Sent

APPENDIX III-C-5d

UNIFORM HAZARDOUS WASTE MANIFEST

State of California—Health and Welfare Agency
Form Approved OMB No. 2050—0039 (Expires 9-30-88)
Please print or type. *(Form designed for use on elite (12-pitch typewriter)*

Department of Health Services
Toxic Substances Control Division
Sacramento, California

IN CASE OF AN EMERGENCY OR SPILL, CALL THE NATIONAL RESPONSE CENTER 1-800-424-8802; WITHIN CALIFORNIA CALL 1-800-852-7550

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No.: CAD123456789 — Manifest Document No.: 000001

2. Page 1 of 1 — Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
NAME OF SCHOOL
MAILING ADDRESS
CITY, STATE ZIPCODE
4. Generator's Phone (213) 123-4567

A. State Manifest Document Number: 87121758
B. State Generator's ID: HA-HQ36-000000
C. State Transporter's ID: 54652
D. Transporter's Phone: (213)555-1234
E. State Transporter's ID:
F. Transporter's Phone:
G. State Facility's ID:
H. Facility's Phone: (805) 937-8449

5. Transporter 1 Company Name: TRANSPORT CORP. — 6. US EPA ID Number: CAD000098765
7. Transporter 2 Company Name: — 8. US EPA ID Number:

9. Designated Facility Name and Site Address
CASMALIA RESOURCES
N.V.T. ROAD
CASMALIA, CA 93429
10. US EPA ID Number: CAD020748125

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. WASTE, FLAMMABLE LIQUID, NOS FLAMMABLE LIQUID UN1993	003	DM	01000	P	State 551 EPA/Other D001
b. WASTE, OXIDIZER, CORROSIVE LIQUID, NOS OXIDIZER NA9193	002	DM	00750	P	State 551 EPA/Other D001
c.					State EPA/Other
d.					State EPA/Other
(REFERENCE: 49 CFR SEC 172.101 FOR ABOVE ITEMS)					

J. Additional Descriptions for Materials Listed Above
A) DRUM # 1,2,3
B) DRUM # 4,5

K. Handling Codes for Wastes Listed Above
a. b. c. d.

15. Special Handling Instructions and Additional Information
WEIGHTS AND VOLUMES ARE APPROXIMATE
SEE ATTACHED LIST FOR DRUM CONTENTS

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

GENERATOR

Printed/Typed Name	Signature	Month	Day	Year
GENERATOR'S NAME	Generator	01	01	87

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year
TRANSPORTER'S NAME	Transporter	01	01	87

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name	Signature	Month	Day	Year

SAMPLE

DHS 8022 A (1/87)
EPA 8700—22
(Rev. 9-88) Previous editions are obsolete.

White: TSDF SENDS THIS COPY TO DOHS WITHIN 30 DAYS
To: P.O. Box 3000, Sacramento, CA 95812

INSTRUCTIONS ON THE BACK

APPENDIX III-C-5e

CAL-OSHA REGISTRATION FORM FOR POSSESSION OF CARCINOGENIC CHEMICALS

This letter may serve as a registration for carcinogen use in accordance with Title 8, California Administrative Code, Sections (as listed below), indicating use of the following carcinogen(s). Check the substances that are used in your workplace.

5208

_____ Asbestos

5209

_____ 2 – acetylaminofluorene

_____ 4 – aminodiphenyl

_____ Benzidine and its salts

_____ Bis (chloromethyl ether

_____ 3, 3' – dichlorobenzidine and its salts

_____ 4 – dimethylaminoazobenzene

_____ Beta – naphthylamine

_____ N - nitrosodimethylamine

_____ Beta - propiolactone

_____ Methyl chloromethyl ether

_____ Alpha - naphthylamine

_____ Ethyleneimine

_____ 4 – Nitrobiphenyl

5210

_____ Vinyl chloride

5211

_____ Coke oven emissions

5212

_____ 1, 2 – dibromo – 3 – chloropropane DBCP

5213

_____ Acrylonitrile

5214

_____ Inorganic arsenic

5215

_____ 4, 4' – Methylene bis (2 Chloroaniline) MBOCA

5219

_____ Ethylene dibromide (EDB)

5220

_____ Ethylene Oxide (EtO)

_____ Other:_____

CAL/OSHA 183
April 1985

APPENDIX III-C-7

DEPARTMENT OF TRANSPORTATION HAZARD CLASSES

The Department of Transportation (DOT) has completed a list of materials designated as hazardous for the purpose of transportation of those materials in commerce. The list, a "Hazardous Materials Table" in the *Code of Federal Regulations, Title 49, Transportation*, specifies for each listed material a *Hazard Class* which affects its required packaging, mailing, and labeling. The Hazard Class specification is important to anyone who will be shipping these materials either for initial use or for disposal.

The hazard class is included in this publication for each chemical listed in the "Potentially Hazardous Chemicals Found in Laboratory Supplies" on pages 42 to 65.

An explanation of the terms used for DOT hazard class is as follows:

The column entitled *Hazard Class* provides information synthesized by the U.S. Department of Transportation concerning safe transport of hazardous materials in commerce. The groups include: explosives, combustible liquids, compressed gases, corrosives, flammable gases, flammable liquids, flammable solids, and poisons. A complete description of these groups follows.

Explosives

Class A--Liquid or gaseous explosives which, in general, function by detonation and include such devices as blasting caps, detonating primers, ammunition for cannon, grenades, bombs, rockets, torpedoes, and so on.

Class B--Those explosives which generally function by rapid combustion rather than detonation as in Class A. This class includes such items as special fireworks, flash powders, some pyrotechnic signal devices, and liquid or solid propellant explosives.

Class C--Certain types of manufactured articles which contain class A or class B or both as components but in restricted quantities, and certain types of fireworks.

Combustible Liquid

Any liquid that has a *flash point** at or above 100° F (37.8° C) and below 200° F (93.3° C).

Compressed Gas

Any material or mixture having in the container an absolute pressure exceeding 40 pounds per square inch (psi) at 70° F, or regardless of the pressure at 70° F, having an absolute pressure exceeding 104 psi at 130° F; or any liquid flammable material having a vapor pressure exceeding 40 psi absolute at 100° F.

Corrosive

A liquid or solid that causes visible destruction or reversible alterations in human skin tissue at the site of contact, or in the case of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

*The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

Flammable Gas

Any material that meets the definition of compressed gas outlined above or meets any of the properties below:

- Either a mixture of 13 percent or less (by volume) with air forms a flammable mixture or the flammable range with air is wider than 12 percent, regardless of the lower limit.
- There is any significant propagation of flame away from the ignition source.
- There is any explosion of the vapor-air mixture in the drum.

Flammable Liquid

Any liquid having a flash point* below 100° F (37.8° C).

Flammable Solid

Any solid material other than one classed as an explosive, which, under conditions normally incident to transportation, is liable to cause fires through friction, retained from heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious transportation hazard. Included are spontaneously combustible and water-reactive materials.

ORM--(Other Regulated Materials)

These miscellaneous materials that are not covered by any of the other classes which may pose an unreasonable risk to property or people. There are five types:

- ORM A--Irritating or noxious substances
- ORM B--A corrosive that dissolves one quarter inch of aluminum per year
- ORM C--A "catch all" category of substances that have inherent properties and that require special handling
- ORM D--Substance with limited hazards including consumer products such as bleach
- ORM E--A substance not included in any hazard class and that commonly is in the form of hazardous waste

Poison A

Poisonous gases or liquids of such a nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life.

Poison B

Those substances, liquid or solid (including pastes and semisolids), other than class A poisons or irritating materials, which are known to be so toxic to humans as to afford a hazard to health during transportation; or

*The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

which, in the absence of adequate data on human toxicity, are presumed to be toxic to humans because they fall within any one of the following categories when tested on laboratory animals:

Oral Toxicity--Those which produce death within 48 hours of a group of ten or more white laboratory rats weighing 200 to 300 grams at a single dose of 50 mg or less per kg of body weight when administered daily.

Toxicity on Inhalation--Those which produce death within 48 hours of more than half of a group of ten or more laboratory rats weighing 200 to 300 grams, when inhaled continuously for a period of one hour or less at a concentration of 2 mg or less per liter of vapor, mist, or dust, provided such a concentration is likely to be encountered by humans when the chemical product is used in any reasonable foreseeable manner.

Toxicity by Skin Absorption--Those which produce death within 48 hours in half or more than half of a group of ten or more rabbits tested at a dosage of 200 mg or less per kg body weight, when administered by continuous contact with bare skin for 24 hours or less.

Items which do not have Hazard Class ratings should still be handled with care. The U.S. Department of Transportation has not rated all items.

APPENDIX III-C-10

TABLE OF HAZARDOUS SUBSTANCES AND CHEMICALS IN COMMON USE: HAZARDS AND PRECAUTIONS

(Hazard rating: 5=Very Dangerous; 1=Slighty Hazardous)

Substance	Hazard Rating	Hazards	Precautions
Acetic Acid	2	Skin, eye burns Lung irritant Chronic bronchitis	Adequate ventilation Chemical goggles Cartridge respirator Rubber gloves
Acetone	3	Flammable Eye, nose, throat irritant Contact dermatitis	Avoid flame, sparks, heat. Chemical goggles Rubber gloves
Acids (General)	3	Eye, nose, throat irritants Corrosive to tissue	Approved respirators Rubber gloves and apron Face shields or goggles Avoid prolonged exposure.
Aluminum Metal Powder	1	Ignites on contact with water, alkalis, or acids	Avoid flame, sparks, heat. Avoid water, acid, alkali.
**Asbestos	5	Carcinogen	DO NOT USE.
**Benzene	5	Known carcinogen Eye, nose, throat irritant Respiratory damage Flammable	DO NOT USE.
Calcium Oxide (Lime)	2	Water/moisture creates heat Eye, upper respiratory irritant Dermatitis, skin burns	Store in cool, dry place. Approved respirators Goggles
Carbon Black	2	Explosive dust Accumulations easily combustible	Good housekeeping Avoid flame, sparks. Goggles and respirators
**Carbon Tetrachloride	5	Carcinogen	DO NOT USE.
**Chloroform	5	Carcinogen	DO NOT USE.

* Often considered more hazardous than their educational value. Districts are advised to make their own decisions.
** Dispose of immediately.

Substance	Hazard Rating	Hazards	Precautions
*Chromic Acid	4	Oxidizer Nasal septum irritant Respiratory irritant May cause skin ulcers Possible carcinogen	Chemical goggles Approved respirators Full body protection and gloves Provide eye wash facility.
Dust (Nontoxic)	2	Nose, throat irritants Prolonged exposure leads to respiratory problems.	Good housekeeping Adequate ventilation Approved respirators
Epoxy Resins	3	Skin, mucous membrane irritant	Avoid prolonged exposure. Approved respirator Eye, face protection
Fibrous Glass	3	Skin irritant Prolonged exposure may cause respiratory problems.	Adequate ventilation Full clothing Approved respirator for cutting or sanding
*Formaldehyde	4	Eye, nose, throat irritant Allergic sensitization--Skin If heated, creates formic acid Possible carcinogen	Adequate ventilation Body protection, gloves
Gasoline	4	Highly flammable Nose, throat irritant	Avoid flame, sparks, heat. Store only in approved containers. No prolonged exposure to fumes
Graphite, Powder	2	Explosive dust	Approved respirator Goggles Avoid heat, sparks flame.
Hydrochloric Acid (Muriatic)	3	Corrosive Nose, throat irritant Skin burns Suffocant	Approved respirator Goggles, gloves
Hydrogen	2	Explosive	Avoid sparks, flame. Keep away from oxygen, chlorine.

* Often considered more hazardous than their educational value. Districts are advised to make their own decisions.
** Dispose of immediately.

Substance	Hazard Rating	Hazards	Precautions
Kerosene	3	Flammable Nose, throat irritant	Avoid sparks, flame, heat. Avoid prolonged exposure to fumes. Face shield, approved respirator
Lacquer Thinner (see Acetone)	4	Flammable Vapors may cause nausea.	Adequate ventilation Avoid flame, sparks, heat. Approved respirator
Lead	3	Dust causes weakness, eye problems, headache. Anemia and systemic damage due to excess exposure	Work with wet lead Approved respirator Special training and medical approved
Mercury	4	Heat creates toxic vapor. Vapor causes systemic damage.	Avoid flames and heat. Use special procedures to clean spills.
Methyl Alcohol (Methanol)	3	Flammable Poisonous if swallowed Eye irritant, headache Drowsiness, vision failure	Avoid prolonged exposure to fumes. Avoid sparks, flame, heat. Use approved respirator.
**Methylene Chloride	5	Carcinogen Eye, skin irritant May cause fatigue, drowsiness	DO NOT USE.
Mineral Spirits (paint thinner)	4	Flammable Nose, throat irritant	Avoid flames, sparks, heat. Approved respirator, face shield
Nitric Acid	4	Corrosive Acid burns Skin, eye irritant Suffocant Can ignite many combustible materials	Good ventilation Rubber gloves, approved respirator Clean up spills immediately.
Organic Solvents	3	Flammable Skin irritants Eye, nose, throat irritants	Avoid flame, sparks, heat. Adequate ventilation Approved respirators Gloves and goggles
Phosphoric Acid	4	Acid burns Eye, nose, throat irritants	Approved respirator, rubber gloves

* Often considered more hazardous than their educational value. Districts are advised to make their own decisions.
** Dispose of immediately.

Substance	Hazard Rating	Hazards	Precautions
Plastics	2	Decompose into toxic gases when heated Bonding agents may have toxic vapors. Dermatitis from dusts	Keep away from high heat, flame. Wear respiratory protection for exposure to vapors. Use adequate body protection .
Propane	4	Flammable	Avoid flame, sparks, heat. Move and store cylinders properly.
Sodium Hydroxide (Caustic Soda)	4	Eye, nose irritant Skin burns	Goggles Rubber gloves, apron
Sulfuric Acid	4	Violently reactive with water and organic materials Corrosive to body tissues Pulmonary edema	Avoid prolonged exposure to fumes. Rubber gloves and apron Chemical goggles
Toluene	4	Flammable Skin irritant Vapors cause dizziness, muscular fatigue, narcosis.	Avoid prolonged exposure. Approved respirator Rubber gloves
Turpentine	3	Eye, nose, throat irritant	Avoid prolonged exposure. Adequate ventilation Goggles, rubber gloves
Xylene	3	Flammable Eye, nose, throat irritant Vapors may cause drowsiness.	Avoid flame, sparks, heat. Adequate ventilation Approved respirator

* Often considered more hazardous than their educational value. Districts are advised to make their own decisions.
** Dispose of immediately.

APPENDIX III-D-3

SAFETY PRECAUTIONS FOR ROCKET LAUNCHINGS ON SCHOOL SITES

State fire laws were changed so that it is now possible to launch model rockets on school sites, provided that the conditions outlined in this appendix are observed.

Activities involving the firing of rockets must be well planned. It is recommended that launchings be limited to not more than ten rockets if an audience will be present. Only authorized classes and clubs may engage in this type of activity.

Guidelines for the firing of model rockets on school sites.

1. *Purpose.* These regulations have been prepared for the purpose of establishing reasonable safety standards for the testing and flying of model rockets. Model rockets are classified as nonprofessional rockets which are propelled by approved commercially manufactured solid propellant engines.

2. *Special Permit.* At least four weeks prior to the date selected for the firing of model rockets, the school shall submit a firing request to the responsible district office. A special permit shall be obtained from the fire department for a given period. It is usually the fire department's policy to issue such a permit to cover a brief time. The permit is issued in the name of the school administrator. The instructor shall comply with all safety standards and conduct the launching in a manner that is also acceptable to the school administrator.

3. *Size of Rockets.* Rockets with a class A or smaller engine are strongly recommended. Configuration of the rockets is not limited except as to weight (four ounces [112 gm] with engine) and length (not less than ten inches [25 cm] nor greater than 15 inches [38 cm]). The rocket shall contain no metal parts.

4. *Launch Site Standards*

   a. The launch site shall consist of a firing area and a recovery area. The firing area shall be considered that area surrounding the launching devices contained within a radius of 25 feet (8 m) outward from the location of the launching platform. The recovery area shall include the firing area and shall be determined to be the minimum area necessary to retrieve the launched rocket.

   b. The minimum size of the launch site shall be a radius of at least 100 feet (30 m) from the firing position.

   c. The launch site shall not be located in a grain field, area of dry grass or bush, or forested area.

   d. The launch site shall not contain nor be located near any high voltage line, major highways, or any other obstacles deemed hazardous by the fire department.

   e. The launch site shall not include any buildings nor other structures unless approved by an official from the fire department.

   f. The firing area shall not be located closer than 25 feet (8 m) to the boundary of the launch site.

5. *Launching Facilities.* Model rockets shall be launched only from platforms meeting the following conditions:

   a. A launch guide (tube, wire, or other suitable device) shall be used to restrict the horizontal motion of the rocket until sufficient flight velocity is achieved to maintain stability during flight. Ignition of the model rocket engine shall be by remote electrical means and shall be only under the control of the person launching the rocket. The launch shall be properly supervised by the instructor in charge.

   b. The launching angle shall be not less than 75 degrees from the horizontal plane.

   c. The surface wind at the launch site shall not exceed 18 miles per hour (30 km per hour), and vertical visibility from the firing area shall be at least 715 yards (650 m).

   d. The recovery device material (parachute or other) ejected from the rocket during the flight sequence shall be of flame-resistant material.

   e. The model rocket shall be launched only during daylight hours (except when otherwise specifically approved by the fire department).

   f. All personnel conducting or observing the firing shall maintain a clear distance of not less than 25 feet (8 m) from the launch platform during the countdown and firing. The firing site shall be clearly blocked off, using rope or some other temporary measure.

   g. Only one source of power shall be used for each launch site. No vehicles shall be within the firing site area.

   h. The person launching the rocket shall make all electrical connections at both the firing platform and the source of power.

   i. All spectators shall be positioned upwind of the firing areas and at a distance of at least 25 feet (8 m) away from the firing site.

6. *Supervision.* The instructor in charge of the firing site shall supervise the arming of the rocket with the rocket engine, the firing of the rocket, and the disposing of all unfired or defective rocket engines. A second adult shall be responsible for the safety of spectators and of all other persons who may be present.

7. *Misfires.* After any misfire, the rocket shall be allowed to remain in the launch position for at least one full minute before the rocket is approached. All disarming shall be performed under the supervision of the instructor in charge. The person checking the misfire shall wear a face shield.

APPENDIX IV-B-2

Health and Safety Codes: Animal Care

Section 1650

The public health and welfare depend on the humane use of animals for scientific advancement in the diagnosis and treatment of human and animal diseases, for education, for research in the advancement of veterinary, dental, medical and biologic sciences, for research in animal and human nutrition, and improvement and standardization of laboratory procedures for biologic products, pharmaceuticals and drugs.

Section 1651

The State Department of Health shall administer the provisions of this chapter.

Every provision of this chapter shall be liberally construed to protect the interests of all persons and animals affected.

As used in this chapter, "person" includes: laboratory, firm, association, corporation, copartnership, and educational institution.

As used in this chapter, "board" or "department" means the State Department of Health Services.

Section 1660

The department shall make and promulgate, and may thereafter modify, amend or rescind, reasonable rules and regulations to carry out the purposes of this chapter, including the control of the humane use of animals for the diagnosis and treatment of human and animal diseases, for research in the advancement of veterinary, dental, medical, and biologic sciences, for research in animal and human nutrition, and improvement and standardization of laboratory procedures for biologic products, pharmaceuticals and drugs. Such rules and regulations shall include requirements for satisfactory shelter, food, sanitation, recordkeeping, and for the humane treatment of animals by persons authorized by the board to raise, keep, or use animals under the provision of this chapter. The department shall not make or promulgate any rule compelling the delivery of animals for the purpose of research, demonstration, diagnosis, or experimentation.

Section 1662

The department is hereby authorized to inspect any premises or property on which the animals are kept for experimental or diagnostic purposes, for the purpose of investigation of compliance with the rules and regulations adopted hereunder. Such inspection or other method of control shall be enforced only be employees of the department and such power may not be delegated to any other person or agency.

APPENDIX IV-D-1

FIRST AID* AND SAFETY MATERIALS

Band-aids

Antiseptic

Antiseptic Applicators

Cotton

Baking Soda--in the event of acid burns

Sodium Bicarbonate (saturated solution)--for neutralizing spilled acids

Acetic Acid (31% [5 M] solution)--for neutralizing spilled bases

Bucket of Sand or Commercial Absorbent--to smother alkali fires, dam around spills, reduce slippery conditions, and so on.

Mercury Cleanup Chemicals (for example, zinc dust)

Safety Equipment:

Eyewash/Shower Unit

Fire Blanket

Fire Extinguisher(s), multipurpose (2A-10B,C)

Earthenware Crock (for disposal of solid chemicals) (If needed, have several, labeled to prevent mixing incompatible chemicals.)

Splash-proof Goggles (for every student, instructor, visitor)

Face Shields

Aprons

Fume Hoods (where appropriate)

Rubber and Nitrile Gloves

*This list is purposely conservative because the school health office (or school nurse) should have more extensive supplies.

APPENDIX IV-D-2

OUTBREAKS OF COCCIDIOIDOMYCOSIS ASSOCIATED WITH FIELD WORK

Recommendations for Prevention from the
California State Department of Public Health

There has been increasing public health concern regarding outbreaks of coccidioidomycosis (Valley Fever) among archaeology students in California. The purpose of this statement is to place the problem in its proper perspective and to list precautions which we feel should be taken in order to help prevent future outbreaks.

On November 24, 1970, the Bureau of Communicable Disease Control, State Department of Public Health, wrote anthropology departments of California colleges that susceptible students and faculty were at risk of acquiring coccidioidomycosis on archaeologic expeditions, and it was suggested that this risk be made known to all who might participate in field work in areas endemic for this disease.

Additional outbreaks of coccidioidomycosis have occurred in California among archaeology students since then. Illness rates have exceeded 50 percent in several student groups, and serious disseminated diseases (which required protracted hospitalization and treatment) occurred in a few instances. Outbreaks have continued to occur year after year at sites known to be contaminated with the fungal agent causing coccidioidomycosis.

Coccidioidomycosis can be contracted by minimal exposure to dusty soil in endemic areas. Almost all of the millions of people who are lifetime residents in these areas eventually develop infection and a lifetime immunity from this soil fungus. However, when groups of persons from nonendemic areas enter endemic areas to engage in field activities which include excavation, particularly archaeological digging, a high infection and illness rate can result from a relatively brief exposure.

Therefore, we recommend the following to all school programs engaged in *any* field work involving extensive exposure to dusty soil in areas endemic for coccidioidomycosis:

1. No educational institution should require students or faculty to participate in field work in areas endemic for coccidioidomycosis. Alternative course work should be considered in satisfying course requirements.

2. Information on coccidioidomycosis should be made available to all prospective students and faculty. Recommended references should include at least:

   a. Loofbourow, J. C., and D. Pappagianis. *Coccidioidomycosis--An Occupational Hazard for Archaeologists*. Society for California Archaeology, Special Report No. 2, December, 1971.

   b. *Coccidioidomycosis (or Valley Fever)*. Sacramento: California State Department of Public Health, 1969.

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